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ABSTRACT

This booklet presents evidence to support the idea that distinctions between the instructional and research applications of the computer are becoming blurred. The issue includes contributions from authors who are at the forefront of computer-assisted instruction (CAI) development in their respective fields. An attempt is made to represent most disciplines in the humanities, with emphasis on English, foreign languages, English as a second language (ESL), classics, history, music, and philosophy. All of the articles accomplish at least one of three functions: (1) constitute an overview of CAI in the discipline; (2) focus on a specific representative contribution of the computer; or (3) state more philosophically how computers can be relevant to their field. Currently, CAI is field in the process of maturation. Obstacles to growth include the need for systematization and standardization of courseware, the inherent conservatism of the educational system, and the need for improved hardware. The issue concludes with a book review of current writings on computers and education. (RSL)

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A Special Double Issue on
COMPUTER-ASSISTED INSTRUCTION

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Special Double Issue on
Computer-Assisted Instruction

Edited by

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University of Western Ontario

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Introduction

The Adolescence of Computer-Assisted Instruction

Some twelve months ago I was invited to be guest editor of a special issue of *Computers and the Humanities* devoted to computer-assisted instruction (CAI) in the humanities. Not only was I flattered, I was also delighted that *CHum* was giving special attention to CAI. In February 1983, at the New York headquarters of the Modern Language Association, a conference was held on CAI in the high school and undergraduate curriculum. At that meeting Joe Raben informed the assembled delegates, most of whom had a primary interest in CAI, that the distinctions between the instructional and research applications of the computer were becoming blurred. The following pages will, amongst other things, give evidence to support that claim. Readers of *CHum* with a primary interest in research applications of the computer may consider this phenomenon important.

In planning the special issue I attempted to solicit contributions from authors who were at the forefront of CAI development in their respective areas. The result is a list of authors who, as well as being respected teachers and academics, have had several years experience in the instructional applications of computers. An attempt was also made to represent most disciplines in the humanities, specifically English, foreign languages, English as a second language, classics, history, music and philosophy. While some disciplines associated with the humanities are not specifically represented, many of the ideas expressed in the following pages are general enough to apply to any discipline.

The contributors were asked to collaborate on providing an insight into the real and potential applications of the computer in the major humanities disciplines. It was suggested that the articles could perform one of three functions: constitute an overview of CAI in the discipline, focus on a specific representative contribution of the computer, or state more philosophically how computers can be relevant to their field. Some authors have responded by concentrating on a single objective, while others have addressed all three.

To my mind, this collective vision of CAI shows a field in the process of maturation, the current point being perhaps that of adolescence. "La plus délicate des transitions, l'adolescence," wrote Hugo, "le commencement d'une femme dans la fin d'un enfant." Pusack and Otto themselves use the very term, whilst Smith, Kiefer and Gingrich refer to computers "coming of age." Certainly, the articles in this volume show that CAI has long since progressed beyond infancy. The sophisticated series of programs to assist in the development of composition skills used at Colorado State University; the simulations of Versluis; Burghardt's authoring system for languages; the techniques for generative CAI developed by Culley; Ager's extensive *VALID* and *EXCHECK* programs for logic—all represent considerable maturity in both complexity of software design and appropriate educational applications.

With greater maturity comes a growing awareness of the problems that must be faced if an endeavor is to succeed. The authors are conscious of the multifarious obstacles that must be negotiated. Deryn Watson, for example, admits that some experiments in CAI do little more than show us where

improvements need to be made. In teaching history, Pycior's survey shows the limited acceptance of computers beyond the use of statistical packages. Moreover, he cites not only indifference among some faculty members, but actual hostility. Arenson mentions the need for more courseware and improved hardware for music instruction. Other problems are raised: the need for systematization and standardization of courseware; the inability of even CAI developers themselves to recognize the original contributions of the computer to the learning process; the inherent conservatism of the educational system and those who constitute it.

Concomitant with this awareness of the problems—and to some extent because of it—the authors express a collective confidence in the future of CAI. Many create exciting but credible scenarios of subsequent stages in the development of CAI in the humanities. Wyatt, for example, illustrates the large number of possible applications of the computer-controlled videodisc, and many of his suggestions are eminently feasible even with currently available hardware. DeBloois also deals with the videodisc, and he paints a colorful picture of interactive programs that make students participate in their own education. Though they warn that implementation may not occur in this century, Pusack and Otto show in their blueprint of computer applications in foreign languages that most language skills can be enhanced by CAI. Burns gives specific examples of intelligent programs that will hone students' rhetorical skills, and he expresses the belief that from the artificial intelligence laboratories there may soon emerge systems that make inferences and go at least some way toward understanding natural language.

The collective vision presented in this volume, in short, contains breadth and depth, practical wisdom and speculative adventure, caution and excitement. Indeed, in these articles most of what should be said about computer-assisted learning in the humanities has been said.

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Computation in the Philosophy Curriculum

Tryg A. Ager

Computation and Philosophy

Because the philosophy curriculum is traditionally open-ended and adventurous, it is not surprising to find some of the most sophisticated applications of computer-assisted instruction in this discipline. Computers are of interest to philosophers not only because they provide a modern focal point for the minds-vs.-machines issues in epistemology, metaphysics, and philosophical psychology, or because computer programming languages raise interesting issues in formal logic and the philosophy of language, or because the use of computers in society poses important moral questions, but also because logic is an ideal subject matter for exploring the capabilities and limitations of computers as teachers.

Uses of computers in instruction have been studied for more than twenty years, and from the beginning symbolic logic has played an important role in the evolution of computer-assisted instruction. The first research on computer-assisted instruction in logic was done by Patrick Suppes' group at Stanford University. As early as 1965 grade school children were doing truth value analysis and interactive proof construction [20]. In another project in 1974 at Stanford, gifted high school students were allowed to take a computer-based course in elementary logic to test hypotheses about self-directed home study using remote computer terminals [15]. These early projects established the feasibility of computer-assisted instruction in logic at many age and ability levels, defined many of the design and evaluation issues surrounding computer-assisted instruction, and set standards for many subsequent projects at Stanford and elsewhere.

In 1972 a computer-based course in logic was first offered to Stanford undergraduates, and a descendant of that program, VALID, continues to be used today. In the mid-seventies, additional programs for instruction in logic began to appear. The BERTIE program by Moor and Nelson was reported in the summer of 1976 [18]. The ENIGMA program by Laymon and Lloyd began to be used at Ohio State University in 1975 [13]. Covey's ANALYTICS programs for informal logic were put into use at Carnegie-Mellon University in 1979. Before discussing each of these programs in more detail, I will explain why I have singled them out.

The BERTIE proof checker is an example of a computer program designed to supplement traditional methods of instruction. This and other similar programs are intended to be homework checkers for derivation problems in a regular logic course.

The ANALYTICS program is also a supplement to a traditional course, but emphasizes informal logic and the analysis of unformalized reasoning. It is integrated into the teaching of informal logic along the lines of a "logic laboratory."

The ENIGMA program was one of the first large-scale CAI projects to be cost-effective in a university situation. It is an integral part of a heavily enrolled one-quarter course in beginning logic at Ohio State University.

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The VALID program is not intended to supplement or be a part of a traditional lecture, textbook, and classroom course. Rather, it is an alternative way of teaching symbolic logic, where primary instructional responsibility is borne by the computer program.

Thus, there already is a substantial history of development and a range of established yet interestingly different applications of computer-assisted instruction in philosophy. This survey will establish a background by describing in greater detail the above programs and related work, then discuss the implications of computer-assisted instruction in philosophy, and finally consider directions future work in the area could take.

Supplemental CAI in Symbolic Logic

Moor and Nelson wrote BERTIE (named for the philosopher Bertrand Russell) because they perceived interactive computing as a good environment for developing the skills of derivation construction in symbolic logic. The fundamental idea of interactive proof checking is that, in the construction of a derivation, each step can be evaluated for correctness from information available in preceding lines of the derivation and in the set of rules of inference comprising the logic system.

One gets started with BERTIE either by requesting one of its stored problems or by setting up one's own deduction. Below is an example of the complete construction of a derivation where the user enters the conclusion to be derived to get started (not shown), then enters two premises and works toward the conclusion, making a mistake at line 6 and putting in lines 4 and 5, which are unnecessary. The example is from Moor and Nelson's 1976 report [18]. (It is a convention of this article that underlined text represents input typed by the user of the program.)

```
1 ? (x)([Px & (E y)(Py & Lxy)] = > (z)(Pz = > Lzx)) / P
2 ? Pa & (E y)(Py & Lay) / P
3 ? Pa & (E y)(Py & Lay)= > (z)(Pz = > Lza) / 1, UI
4 ? /2 COM
4   (E y)(Py & Lay) & Pa                    / 2 COM
5 ? /4 SIMP
5   (E y)(Py & Lay)                         / 4 SIMP
6 ? Pa & Laa / 5 EI
ONE CAN EXISTENTIALLY INSTANTIATE ONLY TO PSEUDO-NAMES
INCORRECT USE OF RULE CITED
6 ? /2,3 MP
6   (z)(Pz = > Lza                          / 2,3 MP
7 ? Pa = > Laa / 6 UI
8 ? /2 SIMP
8   Pa                                      / 2 SIMP
9 ? 7,8 MP
9   Laa                                     / 7,8 MP
CONGRATULATIONS! YOUR DEDUCTION IS COMPLETE.
LINE 4 IS SUPERFLUOUS.
LINE 5 IS SUPERFLUOUS.
(YOU MAY USE 'REMOVE')
```

Fig. 1 Example of a Derivation in BERTIE

A characteristic of an interactive proof checker is that incorrect steps of inference are never sanctioned by the program. The rigor of formal deduction is thus put into practice for students by the proof-checking program BERTIE is a line-by-line checker, and does not deal with proof strategies in a computational sense, although for its repertoire of stored problems, it is prepared to give a stored hint about a strategy for solving the problem.

A proof checking program called EMIL (named for the logician Emil Post) which does take account of problem-solving strategy was developed at Notre Dame by Garson and Melloma [8]. This program is a good example of how theoretical understanding of logical systems can motivate improvements to computer-assisted instruction systems. Garson and Melloma wanted a program that could follow lines of strategy in the solution of derivation problems. Using Gentzen-style rules to characterize the standard propositional and first-order systems, they classified the logical rules of inference as complexity-increasing or decreasing and semantically reversible or not. They formulated rules of strategy expressible in those

concepts, and upon those rules built a dynamic hint and advice system. They thus attempted to add a strategic dimension to a line-by line proof checker. EMIL is intended not only to determine whether an entered line is correct, but also to evaluate the current state of the derivation with respect to its goal.

Interaction with EMIL is organized rather differently than with BERTIE. EMIL allows one to play both ends of the proof against the middle by entering lines at the top of the proof and goals at the bottom. The strategy algorithms then prompt with questions and suggestions about filling in the steps in the middle of the proof.

In the following example, which shows how EMIL is centered on strategy, student inputs have been expanded to be more self-explanatory. The numbers following a slash show logical dependence of lines on premises.

1. (L → P) Assumption / 1

. . .

99. ((L & F) → P)

Hint for 99

Does your goal formula, line 99, have & or → as the main connective? Yes

What is the main connective of your goal formula, line 99? →

→ IN is the rule you will use to derive your goal; add the name of the rule to line 99.
99:→ IN

99. ((L & F) → P) → IN

Hint for 99

You're planning to get line 99 by rule → IN, and this rule always requires that you make a provisional assumption at the top of your proof. Do you know what the provisional assumption (PASM) should be? No

The provisional assumption you should put down as the next step in your proof is (L & F)

(L & F) PASM / 2

Fig. 2 Example of a Derivation of EMIL

The interaction continues in this way, eliciting two more lines from the bottom of the proof, as shown below. The important point is that the now nearly complete derivation has been constructed non-linearly. Supplying the justification for line 97 as &OUT 2 completes the derivation.

1. L → P Assumption / 1
2. L & F Provisional Assumption / 2

97. L
98. P → Out 2, 97
99. (L & F) → P → IN 2,98

Because of its ability to generate hints dynamically, EMIL is an example of an intelligent tutoring system.

Still another supplementary program, the APL Logic Tutorial, was reported by this author in 1976 [2] [3]. As in BERTIE and EMIL, the concept of the tutorial was to supplement regular classroom instruction by giving students the opportunity to work problems in symbolic logic on a computer.

Evaluation of Supplementary Proof Checkers

Classroom use of each of the above programs revealed that students approved of the use of a computer as an aid in learning how to do derivations in symbolic logic. Moor and Nelson did a controlled experiment on the effectiveness of BERTIE as a supplement to regular instruction [17]. They found that in a Keller self-paced course, students were passing the unit tests more quickly. Without BERTIE the average number of tests to pass a unit was 3.23; with BERTIE this number dropped to 2.29. Moor and Nelson also report a connection between time spent using the program and improvement in performance among slower students [18].

This author's use of the APL tutorials accelerated the process of teaching the basics of symbolic logic without change in performance on examinations. Thus much additional material could be included in a one-semester course.

The work on supplementary proof checkers described here all occurred before the personal computer revolution of the eighties. BERTIE is a quarter-megabyte program written in

BASIC. EMIL was written in PL-1, and the APL tutorials are several distinct 64-kilobyte APL programs. Thus almost all the accumulated experience with supplementary proof checkers is on mainframe computers. Moor has produced a redesigned BERTIE II program for small computers. It is also supplemental in nature and is linked to Moor's text [4].

ANALYTICS: Supplementary CAI in Informal Logic

At Carnegie-Mellon University, Covey has produced a set of interactive tutorial programs for a course in informal logic and the analysis of reasoning. Using the appropriate formal analytical methods to specify patterns of arguments, these programs emphasize structure and argumentative content in informal contexts. A number of particularly effective exercises develop skill at identifying the presuppositions and "hidden premises" of arguments. Covey has taken care to give realistic examples from many fields, and avoided using "toy" or trivial examples in the exercises. He has also dealt effectively with the problem of teaching students a technique for symbolizing sentences in ordinary language.

Covey based his program on a view of argument analysis developed independently of issues of computer implementation [7]. The programs themselves are discussed in [6]. Like the rest of the work discussed here, Covey's programs implement intellectual insights, rather than beginning with pre-fabricated authoring systems. The ANALYTICS programs are compact, and have been successfully implemented on personal computers.

ENIGMA: Cost-effective Supplementary CAI

At Ohio State University, an introductory course in logic enrolls between 800 and 1000 students each quarter. A project to use computer-managed instruction in this course began in 1972, and by 1976 Laymon and Lloyd had in place an instructional system that could provide between one and two hours of computer-based material to each student per week [14]. The system, which continues to be used and to be cost-effective, includes extensive facilities for course management such as enrollment, on-line data bases of student grades, training of proctors, modifying curriculum content, and controlling the sequencing among the various modules. Instructors can adapt the program to different purposes, and a thorough student manual is provided [13].

ENIGMA uses test and branch techniques of CAI as well as many special routines. It presents problems in validity, conditionals, syllogisms, necessary and sufficient conditions, and Mill's inductive methods. An exercise on Mill's methods will present a write-up of an experiment, then elicit identification of the relevant relationships between conditioned and conditioning properties. The student works out a table of the relationships, and is required to identify the method of reasoning used and answer other questions about the experimental situation. Exercises in ENIGMA are graded, but they may be repeated and optional problems are available.

Because of the large number of students using it, the ENIGMA program generates exercises dynamically from stored templates, rather than storing many variations of each problem. Generative techniques are efficient operationally and since each student gets a unique group of problems to be graded, they are fair pedagogically.

ENIGMA was developed to solve practical problems in teaching a large introductory course. It demonstrates that with a serious, extended commitment to developing and operating computer-assisted instruction, a university philosophy department can justify an investment of its resources in a technology for teaching.

VALID: The Computer as Teacher

Developed at Stanford University as an alternative to conventional classroom instruction, VALID is the most radical of the applications of CAI in philosophy discussed so far because it transfers most of the instructional responsibility to the computer. Although it has been in continuous operation for more than a decade, the VALID program remains one of the few

courses in any subject taught entirely by computer in a university setting.

In a general way the course is based on Suppes' introductory logic text [23]. But it has acquired its own character by taking advantage of possibilities in the computer medium which are not present in printed materials. Students are not required to use a textbook, and there are no lectures or classroom examinations. The course is entirely "on-line." Teaching assistants are available for questions, and students must meet deadlines during the quarter in order to smooth out usage of the computer resources. Approximately 300 Stanford students per year have enrolled in the course since 1972. Students typically spend about eighty hours working at computer terminals during a ten week academic quarter. The fastest students complete the work in about 45 hours, the slowest in about 150 hours.

The VALID program currently covers the following topics, which form a coherent, rigorous and thorough course in introductory symbolic logic:

1) Derivations and counterexamples in propositional logic
2) Formalization of propositional and first-order sentences
3) Integer arithmetic as a quantifier-free axiomatic theory
4) Derivations and counterexamples in first-order logic
5) Choosing axioms for sets of statements
6) Survey of Boolean algebra
7) Formal methods in the theory of social preference
8) Introductory probability theory

The emphasis in VALID is on theorem-proving in several different formal systems. The interactive proof checker is designed to allow students to develop their logical intuitions and to make substantial inferences, letting the program take care of trivial details. In the following example of a derivation in first order logic, the inference rule TAUTOLOGY is used to compress several steps of trivial sentential inferences. The style of interaction with VALID is that the student directs the program to perform specific inferences. If the directive is correct under the rules, it is done; if it is incorrect an error message is printed. The example includes a transcript of preceding explanatory material and a menu of problems.

Practice with the Quantifier Rules
In the next menu you will get some arguments we have translated into formal notation from English. Study the translation. You will have to provide translations in later exercises! Press RETURN to go on.
*

MENU: You must complete 3 of these entrees.

1 FROM: (E X)[R(X) & (A Y)[Q(Y) → L(X,Y))]]
(A X)[R(X) → (A Y)[I(Y) → NOT L(X,Y)]]
DERIVE: (A X)[Q(X) → NOT I(X)]

2 FROM: NOT (E X)[P(X) & Q(X) & NOT T(x)]
(A X)[T(X) → O(X)]
(E X)[P(X) & NOT O(X)]
DERIVE: (A X)(P(X) & NOT O(X) → NOT Q(X))

3 FROM: W(R) → (E X)[T(X) & H(X)]
(A X)[M(X) → L(X)] →
(A X)[T(X) → NOT H(X)]
DERIVE: W(R) → (E X)[M(X) & NOT L(X)]

4 FROM: (A X)[P(X) → H(X)]
(E X)[I(X) & (A Y)[H(Y) → NOT L(X,Y)]]
DERIVE: (E X)[I(X) & (A Y)[P(Y) → NOT L(X,Y)]]

5 FROM: (A X)[F(X) → D(X)]
NOT D(J)
DERIVE: NOT F(J)

Type an entree number.
*1

P1 Some of Aristotle's followers like all of Aquinas' followers.
(EX)[R(X) & (A Y)[Q(Y) → L(X,Y))]
P2 None of Aristotle's followers like any idealist.
(A X)[R(X) → (A Y)[I(Y) → NOT L(X,Y)]]

```
        :.  None of Aquinas' followers are
            idealists.
            (A X)[Q(X) → NOT I(X)]
DERIVE: (A X)(Q(X) → NOT I(X))
P               ( 1 ) (E X)(R(X) & (A Y)(Q(Y)
                  → L(X Y)))
P               ( 2 ) (A X)(R(X) → (A Y)(I(Y)
                  → NOT L(X Y)))
*hyp
HYP             ( 3 ) Q(X)                    (3)
*1 es
Variable: *x
Ambiguous term: *#
1ES             ( 4 ) R(#) & (A Y)(Q(Y) → L(#
                  Y))
*2 us x
Substitute for X (X): *#
2US             ( 5 ) R(#) → (A Y)(I(Y) →
                  NOT L(# Y))
*4 lc
4LC             ( 6 ) R(#)
*5 6 aa
5,6AA           ( 7 ) (A Y)(I(Y) → NOT L(#
                  Y))
*7 us y
Substitute for Y (Y): *x
7US             ( 8 ) I(X) → NOT L(# X)
*4 rc
4RC             ( 9 ) (A Y)(Q(Y) → L(# Y))
*9 us y
Substitute for Y (Y): *x
9 US            (10) Q(X) → L(# X)
*3,8,10 tautology Not I(x)
3,8,10TAUTOLOGY
                (11) NOT I(X)                 (3)
*3 11 cp
3,11CP          (12) Q(X) → NOT I(X)
*12 ug x
12UG            (13) (A X)(Q(X) → NOT I(X))
You have finished this proof.
Press RETURN to go on.
*
```

Fig. 3 Example of a Session with VALID

Upon completion of the problem, control returns to the menu where another problem can be selected. Work on any problem in the menu may be deferred, and the incomplete derivation stored. If students sign off the computer in the middle of a problem or menu, all their incomplete work is saved. On their return, the work is restored to exactly the same state.

When the task is to prove a theorem in an axiomatic theory, more powerful rules of inference are available that can apply a general theorem to a particular case in one step. Thus, to give a simple example, if an axiom of commutativity is available for addition, then the student can simply apply the general axiom, $x + y = y + x$ to the particular case of $1 + 3 = 4$ to derive $3 + 1 = 4$ without having to indicate that 3 is substituted for x and 1 for y. The intuition "The axiom of commutativity of addition will work here" can thereby be translated into a single command to the proof-construction system, even though many logically primitive operations are actually required. Tedious primitive operations are absorbed by the algorithm, and students learn to operate on a higher conceptual plane.

VALID includes exercises on finding axioms for a set of sentences in a formalized theory. Students are asked to choose a proper subset of a list of formulas as axioms and derive the rest as theorems. One such exercise requires axiomatization of facts about the betweenness relation. In these exercises, because there is no unique solution, students must establish the correctness of their solution by doing the appropriate derivations. The finding axioms exercise on the theory of natural numbers presents a set of 21 formulas, to be axiomatized with eleven statements, the remainder to be proved as theorems. An exercise of this type takes several hours to complete, and as with the menus described above, a provision is made for saving and restoring incomplete work. A study of student solutions to finding axioms problems was done by Goldberg and Suppes in 1972 [9].

VALID contains facilities for messages between students and staff, a course news system, and the capability to browse previous material. In the axiomatic theories, students may prove and save their own theorems and

lemmas for use in future problems. There are more than 550 distinct derivation problems in the curriculum, and numerous other problems and questions that do not require proof construction for their solution.

Because student interaction with the VALID program continues over a period of many weeks, much attention has been given to making the command language for the program perspicuous and consistent. The program is designed in such a way that to get started nothing is required beyond the simplest knowledge of how to log in and log out. Students never directly manipulate files, make requests of the operating system, start or stop programs, or encounter any intimidating aspects of computer programming or use.

Evolution of the VALID program

Some of the history of the VALID program was presented earlier in this article. Since 1972 the program has been known by various names and has been the focus of many research projects, all the while being the principal method for taking introductory symbolic logic at Stanford.

Originally the program ran on teletypes, with a very abbreviated curriculum. This first phase of the program was reported by Suppes and Goldberg [10]. The second version of the program involved enhancing the curriculum with computer-generated audio output in 1976. This major software and hardware engineering project is reported in several articles [24] [22].

The present version of the program was the outcome of another major project combining theoretical work in logic with applied research in software engineering. The purpose was to make VALID portable to establish the viability of completely transportable large-scale CAI systems [1]. Begun in 1978 and completed in 1982, the VALID program was completely rewritten in a portable dialect of LISP, and has proved itself acceptable in the regular offerings of many philosophy, mathematics and computer science departments all over the world. It runs identically on the IBM 370 family of computers and on the Digital DEC 10 and 20 series systems. It is in the process of migrating to Digital's VAX and the Motorola 68000 series processor. The Fund for Improvement of Postsecondary Education supported the transportability project, which was a joint effort by Stanford University and the State University of New York.

Among current college and university users of the VALID program, in addition to Stanford, are LaTrobe University in Melbourne, Australia, Colorado School of Mines, UCLA, Wichita State University, The University of Petroleum and Minerals in Dhahran (Saudi Arabia), Sweet Briar College, the University of California at Irvine, and Carnegie-Mellon University.

Evaluation of the VALID program

At Stanford, the introductory course is evaluated by students under the same criteria as regular courses. The rating of the computer-taught course in logic is usually slightly better than the average Stanford course. Continued high enrollment, between 80 and 120 students each quarter, is evidence of its acceptability to students. Hardware and software reliability are also critical factors in student acceptance. During 1976-1977, when the audio curriculum was being introduced, the frequency of system-related problems increased and student satisfaction decreased. The reactions of the students to the use of audio are discussed in [12].

The most interesting subjective response to the VALID program is the students' view that they receive more individual attention from the computer-taught course than they would in a lecture-discussion situation. This is probably due to two factors: first, the continuous feedback from the program gives much more immediacy to logic instruction than the cycle of lecture, homework, corrections, and exams, a process that typically extends over a period of days or weeks; second, teaching assistants are available to answer questions which arise during terminal sessions. Because detailed and rigorous responses are required by the program, questions arise in a context where specific answers have clear application. Therefore, there is a high likelihood of efficient and satisfying dialog with the instructor or teaching assistant.

An average student session with the VALID program is about two hours. Studies of data regarding student work time were the basis for a queuing system which, when terminal usage is heavy, still allocates resources to permit adequate terminal time for each student. Because the entire course is presented on-line, students must be given adequate time to think once they begin work at the terminal. An adequate allocation of resources is thus another requirement for successful operation of VALID as a teaching program.

Use of VALID at Other Schools

It has already been mentioned that the VALID program has been used by schools other than Stanford. Transporting such a large software system involves many technical considerations and differing pedagogical goals and concerns at each site. In this section I will discuss the problem of transporting a system as large and complex as VALID and describe reactions of other schools to the program.

Operational considerations for a computer program intended to run on a large central computing facility include its installation, administration, and maintenance by local technical staff. When VALID was made portable, care was taken to minimize these interventions. We wanted it to be an instructional asset whose installation and initial use was as unproblematic as acquiring library materials. Requirements for technical support staff could therefore be eliminated from the factors determining whether VALID would be used. This left only pedagogical utility and resource availability as determining factors in a decision to use VALID.

Resource availability seems to carry more weight than pedagogical utility in such a determination. At some schools which have had the program for several years, rapidly increasing demands on computing facilities work against any large program. In some cases VALID has been displaced because computing resources became saturated.

Although the VALID system is intended to teach a full course in symbolic logic with help from teaching assistants or preceptors, not everyone has that goal in mind. It has been used by some schools as a supplement to a regular course. At LaTrobe University in Australia, Richards has used the VALID system as a model for further research on intelligent tutoring systems. At UCLA it was used to teach logic in the summer session. Like any computer program, VALID could be modified in various ways, but beyond local customizations of the top level of the program, users have not attempted internal changes. The system has thus satisfied several different goals. We have come to expect that modern software packages such as word processors or spreadsheets will have general utility. It is now apparent that the body of instruction in VALID, even though it is highly specialized, is acceptable in many different circumstances.

Designing VALID to be a portable system was a task at least as difficult as designing it to be intellectually adequate. But the importance of portable software is that the state of the art is shareable. Thus it becomes possible to advance across a broader front.

EXCHECK: Advanced, Specialized CAI in Logic

Although VALID is a sophisticated program, the EXCHECK system developed by Suppes' group at Stanford goes beyond it in a number of important ways. Where VALID develops the basics of theorem-proving, the EXCHECK system takes students to the expert level, allowing them to interactively rediscover proofs of some of the classic theorems of the foundations of modern mathematics. EXCHECK is an interactive theorem-proving environment where steps of reasoning approximating the informal style of presentation in mathematical literature can be validated by a proof-checking program [19]. Upon such a foundation could be built complete courses, such as axiomatic set theory, proof theory (the Goedel incompleteness result), foundations of probability, and the standard metatheory of logic. These subjects could then be offered regularly without expensive staff commitments, or be taught in departments that lacked the specialized expertise, or be offered regularly regardless of enrollment levels. In this way technology could preserve segments of the

curriculum jeopardized by constraints on the faculty or the academic program.

An EXCHECK course in axiomatic set theory has been in regular use for ten years. The underlying system has been described by McDonald [16], the theorem-proving heuristics are discussed by Blaine [5]. Suppes and Sheehan have studied the properties of proofs students have constructed in the set theory course [21].

The following example is a transcript of a session with the EXCHECK course on axiomatic set theory. The task is to show that if B is a proper subset of C, then C is not a subset of B. The informal English output is one of several output modes possible in EXCHECK.

```
Derive: (A B,C) (If B is a proper subset of C
                 then C is not a subset of B)
assume (1) B is a proper subset of C
assume (2) C is a subset of B
1 eliminate using definition proper subset
           (3) B is a proper subset of C and
               B not = C
2,3 establish
           (4) B = C
2,3,4 contradiction
           (5) C is not a subset of B
QED
           (6) (A B,C) (If B is a proper subset
                        of C
                        then C is not a subset of B)
```

This proof gives a simple example of the computational power of the extra-logical rules of inference available in EXCHECK. Those rules include:

1) ELIMINATE. Replace defined terms.

2) TAUTOLOGY. Decision procedure for propositional inferences.

3) BOOLE. Decision procedure for the algebra of classes.

4) TEQ. Decision procedure for inferences whose validity depends on tautological inference and substitutivity of equality.

5) VERIFY. Inferences by resolution theorem prover using previous steps and/or axioms, definitions, or theorems of the theory.

6) CONTRADICTION. Essentially Reductio ad Absurdum with the power of VERIFY.

7) ESTABLISH. Eliminate defined terms and apply the VERIFY rule

8) IMPLIES. Apply a biconditional or conditional axiom, theorem, or premise to previous lines, with automatic instantiation of universally quantified variables.

9) REDUCE. Automatically find and apply relevant definitions to reduce defined terms to primitives.

10) QED. Apply conditional proof and universal quantification as required to complete a proof.

Students who take the EXCHECK course in set theory prove more than forty mathematically significant, historically important theorems, among them Cantor's diagonalization theorem and the Schroeder-Bernstein theorem. The EXCHECK system is more than five times the size of the VALID program. It is not transportable, although revision to a transportable form is on the agenda at Stanford. The EXCHECK system represents the most that has been done in computer-assisted instruction in philosophy to date, but not the most that could be done.

Implications of CAI in Philosophy

This section will discuss some of the issues that arise when the idea of computer-assisted instruction is taken seriously in the philosophy curriculum. Many of these arguments and observations are not restricted to the philosophy curriculum as such, but bear on the general topic of technology in teaching. If the impact of computer-assisted instruction is considered in abstraction from the specific material being taught, we can formulate several theses about the dynamics of computer-based teaching within the traditional organization of academic departments.

Decoupling Curriculum from Staff

Just as with certain jobs in industry, computer technology now has a capability of substantially taking over tasks heretofore

performed only by teaching staff in colleges and universities. The VALID program has demonstrated this potentiality at Stanford and elsewhere. In a clear example of how the curricular offerings of a department can be extended, symbolic logic is now included in the curriculum of the University of Petroleum and Minerals in Saudi Arabia despite the lack of a philosophy department and any faculty member specifically retained to teach introductory logic.

There are two interesting possible outcomes of decoupling courses from staff. The first is that a department as a whole may become more productive in the sense of offering more courses without adding more staff. The second is that individual instructors, heretofore responsible for teaching similar material time after time, could redirect their efforts to other areas of teaching or research.

Reducing Costs of Instruction

The promise of cost reductions has always been a part of the discussion of computer-assisted instruction. Since costs vary greatly from place to place, and the perception of the ratio of costs to benefits varies from setting to setting, accurate general conclusions cannot be drawn. Nevertheless, the experience accumulated with ENIGMA and VALID can contribute to the continuing analysis of the economics of large-scale computer-assisted instruction in philosophy.

The ENIGMA program shows how cost stabilization and even reduction can be achieved. Since ENIGMA substitutes for recitation or discussion sections in the elementary logic course, the cost of using it is weighed against the cost of staffing recitation sections. Data on student attitudes and performance in elementary logic with ENIGMA suggests that student-teacher ratios are not critical to instructional quality in that course. Therefore staff reductions or enrollment increases need not threaten overall quality.

The economics of VALID are different. A fixed cost of instruction for each student is based on the computational resources required. Staffing requirements are fixed at about forty teaching assistant hours per week for 100 students. Because VALID is a self-contained alternative to traditional instruction, the total costs of VALID may be predicted and weighed against the total costs of traditional logic instruction, provided that a value for the latter quantity can be determined.

Supplemental programs such as BERTIE could achieve cost reductions when used to replace graders, or they could be construed as improving instruction at moderate increases in costs.

For BERTIE and VALID, each of which is available inexpensively, operating expenses are the factor to consider. Operating expenses pale when compared to the development costs for sophisticated programs.

Improving Instructional Quality

The programs I have discussed all seem to impart a sense of quality instruction regardless of the context in which students use them. Thus, computer-assisted instruction for large-enrollment courses may counteract the frequently dissatisfying impersonality of large lectures by providing opportunities for intense active learning.

VALID insures that each student secures an intellectually rigorous experience in the course. The nature of the curriculum is such that students get a wider and deeper exposure to formal systems than in a typical logic course oriented to a textbook. Similarly, the EXCHECK courses are far more rigorous, and can convey that rigor to more students than traditional alternatives.

There seems to be no substance to certain *a priori* arguments against use of computers to teach formal logic and to assist in teaching informal logic. Skills in formal methods are developed through institutionalized practice, and the computer methodologies are well-suited for providing that practice. Far from suffering a dehumanizing experience, students become intellectually engaged, work at their own pace, and do not experience collisions between their individual characteristics and the organized structure of traditional courses. Whereas individual differences in rates of progress are completely ignored in the lockstep of lecture

courses, the most prominent individual difference shown in the use of VALID is time spent to finish a course.

Production and Delivery of CAI Materials for Philosophy

The range of computer-assisted instruction programs mentioned in this article emphasizes that advanced instructional software requires intense, long-term development efforts. Furthermore, none of the programs discussed in this article was developed exclusively within a courseware authoring system. ENIGMA, to operate efficiently, required extensive modifications to a received commercial authoring system. Almost everything important to ENIGMA's successful use in logic instruction is due to Laymon, Lloyd and their co-worders going beyond the supplied authoring system, and making a program which not only provided logic instruction, but did it efficiently on the hardware available.

Successful CAI is necessarily a mix of engineering and pedagogical efforts. The ENIGMA program required massive efforts to squeeze more efficiency out of a general purpose IBM mainframe. The portable version of VALID was as much an exercise in software engineering as it was in improving the content of the program. The mix of skills and commitments of manpower needed for development of sophisticated computer-assisted instruction programs is not easily assembled in academic departments, nor is commitment of a professional academic's time to software development always institutionally justifiable.

Although it is often implied that the cottage industry model—individuals writing programs for their own use—is viable for courseware development, the requirements for intellectually adequate programs soon exceed the capabilities of an individual. Specialists and long-term commitments are necessary for furthering the state of the art in computer-assisted instruction in philosophy. The major project at Ohio State has flourished because in the former case there is a larger institutional commitment to computer-assisted instruction. At Stanford the work on computer-assisted instruction has been part of a long-range research program on automatic theorem-proving, computer-generated speech, and portability as a software design problem.

Delivery of CAI Materials for Philosophy

The majority of successful CAI programs in philosophy have been developed and delivered on mainframes. The stability and long lifetime of mainframe software have permitted sustained efforts such as VALID, ENIGMA, and BERTIE to flourish. The microcomputer world, however, like the world of automobiles and appliances, is one of rapid obsolescence. Today's quality software for micros may not run on tomorrow's machines, and the developers could therefore find themselves continually rewriting programs to keep up with change.

Given the limited support and market for computer-assisted instruction in philosophy, to escape the perils of obsolescence, prudence requires that the software be of durable, portable, open-ended design.

Future Directions

This article has focused on only one component of the philosophy curriculum. But even in the domain of logic there are possible applications of computer-assisted instruction that have not yet been attempted. For example, modal logic and alternative logics are specialized subjects which could be readily taught by computer-based instruction.

The fundamental reason for the early appearance and success of computer-assisted instruction in logic was the existence of algorithms relevant to the fundamentals of logic. Similarly, mathematical laws in physics form the foundation of computer-assisted instruction in that subject. By analogy, then, extension of computer-assisted instruction in philosophy would seem to depend on drawing upon results of basic research.

Current research on natural language processing would bear on further efforts to do computer-assisted instruction in informal logic. The "expert systems" technologies, which facilitate efficient processing of certain data organized as chains of conditional or probabilistic inference, has sometimes been thought to be relevant to new directions in computer-assisted

instruction. Instructional programs based on the expert systems have been used in the training of health care professionals.

That many philosophical specialties depend on the ability to deal effectively with the grammar of natural languages suggests a possible place for a computer-based course on the fundamentals of philosophical applications of grammar. Specialized courses in Greek, Latin, and other languages important to the philosophical tradition could be taught by computer.

Many of the precise arguments of the modern analytic tradition can find alternative expression in the idiom of algorithms and flowcharts. Gordon has "implemented" as a computer program his thesis that emotions depend on beliefs [11]. His paper describes the relationship between the content of an emotion and certain belief types in abstract quasi-algorithmic terms. His program is driven by that structure, leaving content to be filled in interactively. The program then is a testbed of the plausibility of the thesis when applied to various content and, not incidentally, a mechanism for exploring possible counterexamples.

Conclusion

Computer-assisted instruction in philosophy has been successful in both supplementary and primary teaching applications. The programs used in computer-assisted instruction in philosophy are sophisticated, have proved to be acceptable over a long term, and embody aspects of fundamental research and knowledge in philosophy. The computer-assisted instruction effort in college-level philosophy has not been, nor is it likely to be, dominated by the simpler test-and-branch methods made possible by courseware authoring systems. The efforts in philosophy described in this paper provide a sound basis for forming expectations of how computers will affect college teaching in the future.

REFERENCES

1. Ager, Tryg A. and James McDonald, "Transportability of Computer-Assisted Instruction Programs and Curricula," *Proceedings of the Western Educational Computing Conference*, Anaheim CA, 1978.

2. Ager, Tryg A., "APL Tutorials For Elementary Logic," *Proceedings of the Seventh Conference on Computers in the Undergraduate Curriculum*, Binghamton NY, 1976.

3. Ager, Tryg A., "Computer-Based Tutorials in Symbolic Logic at SUNY-Binghamton," in P. R. Baumann, ed., *Computer-Based Instruction*. Faculty Grants for the Improvement of Undergraduate Instruction, Publication Series, Vol. 1, Albany NY: The Research Foundation of the State University of New York, 1982.

4. Bergmann, Merrie, James Moor and Jack Nelson, *The Logic Book*, New York: Random House, 1980.

5. Blaine, Lee, "Programs for Structured Proofs," in Patrick Suppes, ed., *University-Level Computer-Assisted Instruction at Stanford: 1968-1980*. Stanford CA: Institute for Mathematical Studies in the Social Sciences, 1981.

6. Covey, Preston, "Computer-Assisted Instruction in Philosophy," in Solveig Olsen, ed., *Computers and the Humanities*, forthcoming.

7. Covey, Preston, "Formal Logic and Philosophical Analysis," *Teaching Philosophy* 4 (1981), pp. 277-302.

8. Garson, James, and Paul Melloma, "Teaching Logic with EMIL," *Teaching Philosophy* 3 (1980), pp. 453-478.

9. Goldberg, Adele and Patrick Suppes, "A Computer-Assisted Instruction Program for Exercises on Finding Axioms," *Educational Studies in Mathematics*, 4 (1972), pp. 429-449.

10. Goldberg, Adele and Patrick Suppes, "Computer-Assisted Instruction in Elementary Logic at the University Level," *Educational Studies in Mathematics*, 6 (1976) pp. 447-474.

11. Gordon, Robert M., "Fear," *Philosophical Review* 89 (1980), pp. 560-578.

12. Ladagga, Robert, Arvin Levine and Patrick Suppes, "Studies of Student Preference for Computer-Assisted Instruction with Audio," in Patrick Suppes, ed., *University-Level Computer-Assisted Instruction at Stanford: 1968-1980*, Stanford CA: Institute for Mathematical Studies in the Social Sciences, 1981.

13. Laymon, Ronald and Thomas Lloyd, *ENIGMA: A Computer Assisted Logic Course*, Columbus OH: Collegiate Publishing, Inc., 1976.

14. Laymon, Ronald and Thomas Lloyd, "ENIGMA," *Teaching Philosophy*, 2 (1977), pp. 15-28.

15. Macken, E., R. van den Heuvel, P. Suppes, and T. Suppes, *Home Based Education: Needs and Technological Opportunities*, Washington DC: U.S. Department of Health, Education, and Welfare, National Institute of Education, 1976.

16. McDonald, James, "The EXCHECK CAI System," in Patrick Suppes, ed., *University-Level Computer-Assisted Instruction at Stanford: 1968-1980*, Stanford CA: Institute for Mathematical Studies in the Social Sciences, 1981.

17. Moor, James and Jack Nelson, "BERTIE," *Teaching Philosophy*, 2 (1977), pp. 1-6.

18. Moor, James and Jack Nelson, "BERTIE: An Interactive Program for Teaching Natural Deduction," *Proceedings of the Seventh Conference on Computers in the Undergraduate Curriculum*, Binghamton NY, 1976.

19. Smith, R.L., W.H. Graves, L.H. Blaine, & V.G. Marinov, "Computer-Assis'ed Axiomatic Mathematics: Informal Rigor." In O. Lecarme and R. Lewis, Eds., *Computers in Education* (Amsterdam: North-Holland, 1975), pp. 803-809.

20. Suppes, Patrick and F. Binford, "Experimental Teaching of Mathematical Logic in the Elementary School," *The Arithmetic Teacher*, 12 (1965), pp. 187-195.

21. Suppes, Patrick and John Sheehan, "CAI Course in Axiomatic Set Theory," in Patrick Suppes, ed., *University-Level Computer-Assisted Instruction at Stanford: 1968-1980*, Stanford CA: Institute for Mathematical Studies in the Social Sciences, 1981.

22. Suppes, Patrick and John Sheehan, "CAI Course in Logic," in Patrick Suppes, ed., *University-Level Computer Assisted Instruction at Stanford: 1968-1980*, Stanford CA: Institute for Mathematical Studies in the Social Sciences, 1981.

23. Suppes, Patrick, *Introduction to Logic*, New York: Van Nostrand Reinhold, 1957.

24. Suppes, Patrick, Robert Smith, and Marion Beard, "University-Level Computer-Assisted Instruction at Stanford: 1975," *Instructional Science*, 6 (1977), pp. 151-185.

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Computer-Based Instruction in Musicianship Training: Some Issues and Answers

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During the past decade, a phenomenon called "Computer-Based Instruction" (CBI) has begun to permeate the very fabric of the educational establishment. This method of instruction stems from the programmed texts and teaching machines of the 1950s. The computer project at the IBM Thomas J. Watson Research Center and others like it dealt with methods for extending the branching capabilities of teaching machines. Computer-based instruction and instructional research continued throughout the 1960s and 1970s, but only with the advent of the microcomputer did it become affordable and thus widespread.

Long before the electrical engineers and software experts were grappling with the intricacies of computers, music educators were struggling with the thorny issue of "musicianship training." On their interpretation of the word *musicianship,* a general term for a lot of what musicians must know and a great deal of what they must be able to do to function in their jobs, educators differ, but they will usually agree that it includes such areas as ear-training, sight-singing, music theory instruction, and perhaps music history instruction, as well as certain aspects of instrumental and vocal training. It is the purpose of this article to discuss the role of the computer in "musicianship" training and some problems to be faced by those engaged in the development of software and hardware for it.

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The Computer and Music Theory

The acquisition of knowledge by musicians is in many ways similar to the acquisition of knowledge by students in other disciplines. Musicianship training, however, demands of students much more than the simple memorization of facts. They must learn an important set of skills, which must be as automatic to the musician as the "three R's" are to all literate persons. For example, elementary music theory, which is usually learned without much difficulty by reasonably intelligent students, includes (among other things) rhythmic notation, scales, intervals, key signatures, chords, and part-writing. Students must be able to look at a piece of music and immediately recognize the key signature, a chord's function in that key, and the scalar material being used. This ability to identify and construct the harmonic, melodic, and rhythmic elements in a piece of music is analogous to the ability to recognize and solve simple problems in mathematics. If either is really to be used, speed and accuracy are important.

Until the advent of the computer, speedy and accurate identification and construction in music theory came slowly and only through a great deal of workbook or worksheet practice at home or in the classroom. Practice at home was often too leisurely to provide adequate incentive to work through the problems with speed. Furthermore, a student would very rapidly run out of practice examples. Speed drills were sometimes administered in class, but such repetitive work has been a great waste of valuable class time. Now they can be handled easily by computers. With on-board clocks, timed drills are very easily designed, and

randomly produced drill materials enable students to work without fear of running out of examples.

Theory packages are available now for a variety of computers. Some of the notable ones are listed in Table 1 (Arenson, 1983).

The Computer and Ear-Training

The ability to hear what one sees on the written page, to write down what one hears, and to sing or duplicate on an instrument what one hears played or sung is very necessary for the musician. Until the early 1970s, school practice

Table 1
Music Theory CBI Programs

Author	Owner	Program	Computer
Michael Arenson	University of Delaware	GUIDO® Music Learning System	CDC PLATO® Mainframe
Bruce Benward	Micro Music	Music in Theory and Practice Tutor (Vol. 1, 2nd ed.):A Computer-Assisted Supplement	Apple II
Herbert Bielawa et al.	San Francisco State University	Basic Musicianship Drills	Apple II
Mary K. Cowles	Author	Elementary Music Theory Cassettes	Timex/Sinclair
John Eddins Robert Weiss, Jr.	Electronic Software Systems	Elements of Music	Micro-PLATO and Apple II
Lolita W. Gilkes	Author	Early Music Skills; Key Signatures	TI 99/4a
Arthur B. Hunkins	Author	PET/CBM Music Theory Drills	Commodore PET/CBM
Wolfgang Kuhn	Syntauri Corporation	MusicMaster 1.1®	Apple II
George Makas	Micro Music	The Makas Series	Apple II
Barbara Murphy	The Ohio State University	Theory	Amdahl V7
Edgar R. Norton	Author	Seven Music Theory Programs	DEC PDP 11/70
Robert W. Placek	University of Georgia	RWP3—Program for Spelling of Triads and Extended Chords for Piano Class	CDC Cyber 730
Martin Prevel	Les Editions Ad Lib	Open Drills for Music Fundamentals	Exercette®
Colette J. Wilkins	Carnegie-Mellon University	Solfege CAI	Apple II
David Williams	Micro Music	MMI "Mania" Series	Apple II

in such ear-training was an arduous and time-consuming venture for teacher and student alike. Typically the teacher in the classroom would give the student intervallic, melodic, harmonic, chordal, or rhythmic exercises, usually at the piano. The student would then attempt to write down or identify what was heard. For the teacher this procedure was very time-consuming and for the student whose ear was not very perceptive, it was often very frustrating. The teacher rarely knew precisely how well a student was really doing. Through tape laboratories, much like language laboratories, attempts were made to allow the student some practice outside the classroom. Ear-training texts along with accompanying tapes were published for these laboratories. Although some ear-training texts with accompanying tapes were very good (Benward, 1978), students had to monitor their own progress through the tapes and had to be content with a limited number of exercises for each level of difficulty. As with music-theory instruction, the computer allowed students to practice ear-training drills involving timed, randomly generated examples. Some of the more notable ear-training programs are listed in Table 2 (Arenson, 1983).

The Computer and Music Research

Although the music theory and ear-training programs listed in Tables 1 and 2 are only a small sampling of such programs available, they are typical of those on the market. Most of them run on an Apple II microcomputer, mainly because the Apple has been available for a long time and because several synthesizers and keyboards have been created specifically for that machine. An examination of the two tables reveals that only four programs (those by Arenson, Hofstetter, Murphy, and Placek) run on large mainframe computers. This limitation is very interesting in light of the fact that until the late 1970s, when the microcomputer indus-

Table 2
Ear-Training CBI Programs

Author	Owner	Program	Computer
Bruce Benward J. Timothy Kolosick	Micro Music	Harmony Drills Set I	Apple II
Herbert Bielawa et al.	San Francisco State University	Basic Musicianship Drills	Apple II
Charles Boody	Author	Music Tutor	Apple II
Mary K. Cowles	Author	Elementary Ear-Training Cassettes	Timex/Sinclair
Fred T. Hofstetter	University of Delaware	GUIDO® Music Ear-Training System	CDC PLATO® Mainframe
Wolfgang Kuhn Paul Lorton	Syntauri Corporation	MusicMaster 1.1®	Apple II
George Makas	Micro Music	The Makas Series	Apple II
Barbara Murphy James Talley	The Ohio State University	GAMUT	Amdahl V7
Martin Prevel	Les Editions Ad Lib	Open Drills for Ear-Training	Exercette®
Colette J. Wilkins	Carnegie-Mellon University	Solfege CAI	Apple II
David Williams	Micro Music	MMI "Dictator" Series	Apple II

try began to grow, most of the CBI instruction available existed on large computers.

The most elegant of the large systems, PLATO®, has always been expensive and available to only a fortunate few. PLATO terminals possess a very-high-resolution screen equipped with a touch panel which, in addition to an easily learned typewriter keyboard, makes responding simple. A feature of large mainframe computers that has been important to persons in the university research community is the generally available and large auxiliary storage capacity. This storage has made it possible to retain data on student response patterns in order to gain important information on their learning and perception. Even as inexpensive microcomputers become more prevalent in music instruction, large mainframe and minicomputers will still be important in universities for this type of research data collection.

In conventional ear-training, a great deal of research has utilized the data-keeping capabilities of the PLATO system (Hofstetter, 1981). Through such studies, much has been learned about the kinds of errors students make when listening to intervals, melodies, chord qualities, harmonies, and rhythms. For CBI in music, however, the data-keeping features of the computer have not really been utilized. Only a few studies have examined the effectiveness of certain CBI programs. For example, a controlled study was done at Florida State University in 1980 comparing the MEDICI Melodic Dictation program developed there on the FSU PLATO system with conventional in-class melodic dictation (Taylor, 1982). In that study, the gain scores for both the experimental and control groups were not significantly different, but the computer instruction was more efficient. It is possible, although not absolutely confirmed, that in the long-term retention of melodic dictation skills, the computer program in that study may have been more effective than the classroom method.

At the University of Delaware, Hofstetter (1975) experimented during the 1974-75 school year with a freshman ear-training class to determine the impact of the GUIDO® Harmonic Dictation program on student achievement in harmonic dictation. The control group in the study was assigned to a conventional tape laboratory, while the experimental group students worked on the GUIDO materials. A pretest-posttest comparison of the two groups indicated that the students did achieve significantly more through the use of the GUIDO materials than through the use of the taped materials. Other controlled studies in the area of music theory (Arenson, 1982) and Canelos, et al. (1980) have shown that CBI drill-and-practice is more effective than traditional homework and self-practice in learning fundamental music theory skills.

Some Issues to Be Addressed Concerning CBI in Music

The studies discussed above indicate that CBI works very well in musicianship training. As effective as it has been in the music field, however, there are many issues to be addressed and problems to be solved. First of all, most of the CBI programs have been involved only with ear-training and music theory. There is a real need for programs in music literature and appreciation. Eddins (1978) did pioneering work with a random-access audio device developed by EIS and interfaced it with a PLATO system for helping students make stylistic comparisons of various pieces. For more sophisticated CBI in music appreciation and music history courses, videodisc technology holds great promise, with pioneering work being done at the University of Delaware.

Musicologists have only very slowly begun to move into CBI. The same can be said of instructors in instrumental and vocal performance. In spite of pioneering efforts by Diehl (1973) and Simpson and Goodwin (1984) in the development of CBI programs to help students diagnose such problems in their performance as intonation and bad tone quality and even to correct those problems, performance instructors have been very slow to adopt them. The traditional resistance to technology among many musicologists and performers may begin

breaking down only when individuals recognize the benefits of the marvelous tool that has been made available to them.

Furthermore, of the large number of music theory and ear-training drill-and-practice CBI programs in existence, many are quite limited in what they can do and usually reflect the highly specific pedagogical biases of their authors. Although it is impossible to avoid such biases completely in CBI program content, a table-driven program design can introduce enough program flexibility to produce programs useful to different instructors at different institutions and instructional settings. "Tables" or instructor editing files can be found in all programs in the GUIDO Music Learning System (Arenson and Hofstetter, 1983), in which each program reads a set of instructional variables from a master table. These variables determine the questions to be asked, how those questions will be asked, what the screen displays will look like, and how the computer should respond to student performance. The easily-changed master table allows an instructor to individualize the same program for different groups and different instructors to customize the same program to fit with their pedagogical biases.

Table 3 shows one of these tables from the intervals ear-training program. Column 1 contains the number of each unit in the program. The other columns show the titles, modes of dictation, lengths, modes of generation, sizes, interval content, and competencies for each unit. An instructor who wanted to change one of the units could do so by simply typing a different value into the table or could even add totally new units to the program. Instructors need no knowledge of computer programming to edit the table.

Table 3
Master Table Showing Fourteen Beginning Units from the Intervals Program

Unit Number	Title	Mode of Dictation	Length in Seconds	Mode of Generation	Size	Intervals to Be Included												Competency		
						P1	m2	M2	m3	M3	P4	T	P5	m6	M6	m7	M7	P8	Number Right	Number of Consecutive Trials	Time of Response in Seconds
1	P1, M2, P4, M7, Ascending	A	1.5	R	S	X		X			X						X		9	10	4
2	m2, M3, T, M6, Ascending	A	1.5	R	S		X			X		X			X				9	10	4
3	m3, P5, m6, m7, Ascending	A	1.5	R	S				X				X	X		X			9	10	4
4	m2, m3, P4, P5, M7, P8, Ascending	A	1.5	R	S		X		X		X		X				X	X	9	10	4
5	M2, M3, T, m6, M6, m7, Ascending	A	1.5	R	S			X		X		X		X	X	X			9	10	4
6	All Intervals Ascending	A	1.5	R	S	X	X	X	X	X	X	X	X	X	X	X	X	X	19	20	4
7	m2, m3, P4, P5, M7, P8, Descending	D	1.5	R	S		X		X		X		X				X	X	14	15	4
8	M2, M3, T, m6, M6, m7 Descending	D	1.5	R	S			X		X		X		X	X	X			14	15	4
9	All Intervals, Descending	D	1.5	R	S	X	X	X	X	X	X	X	X	X	X	X	X	X	19	20	4
10	All Intervals, Up and Down	M	1.5	R	S	X	X	X	X	X	X	X	X	X	X	X	X	X	19	20	3
11	m2, m3, P4, P5, M7, P8, Harmonic	H	1.0	R	S		X		X		X		X				X	X	14	15	4
12	M2, M3, T, m6, M6, m7, Harmonic	H	1.0	R	S			X		X		X		X	X	X			14	15	4
13	m2, M2, m3, M3, m6, M6, m7, M7, Harmonic	H	1.0	R	S		X	X	X	X				X	X	X	X		14	15	4
14	All Intervals, Harmonic	H	1.0	R	S	X	X	X	X	X	X	X	X	X	X	X	X	X	19	20	4

Key: Mode of Dictation
H = Harmonic
M = Melodic
A = Melodic Ascending
D = Melodic Descending
S = Student Choice
B = Both Melodic and Harmonic

Mode of Generation
T = Top Notes Fixed
B = Bottom Notes Fixed
R = Random Generation
S = Student Choice

Size
S = Simple Only
C = Compound Only
B = Both Simple and Compound

Finally, one of the greatest impediments to widespread use of the computer for ear-training and other CBI applications involving sound has been the quality of the sound produced by many of the sound synthesizers on the market. Even though several very good high-priced synthesizers exist, those generally used with computers for instructional use—the lower priced ones—have some limitations. With the exception of the sound chips available on the Atari 400/800, Commodore 64, and a few newcomers to the market, the sound generators on most microcomputers are deplorable. For individuals who own Apple II or Apple II-compatible machines, decent sound can be obtained only by interfacing the computer with one of the commercially available synthesizers designed to work with these machines. The most popular of these synthesizers include those made by Micro Music/Micro Technology Unlimited, ALF, and Mountain Computer. They are all rather inexpensive ($100-$400) and all work rather well, but they all have certain individual limitations in either intonation or wave-form possibilities (Boody, 1983). These limitations have been overcome by much more expensive synthesizers, the cost of which may be prohibitive for many users. Technological advances in synthesis techniques and synthesizer design will undoubtedly change the situation for the better.

Conclusion

The computer is rapidly changing the way music theory and ear-training are taught in colleges and to some extent at the secondary school level. Much of the laborious drill-and-practice needed in musicianship training is being handled very ably by machines. However, more music appreciation and music history instructors need to become active in CBI program design and development, more music CBI designers need to develop flexible and interesting music theory and ear-training programs, and more high-quality but inexpensive sound synthesizers are needed if CBI musicianship training is to be truly musical and effective.

The problems discussed above, as well as others, were of such concern to people involved with CBI in music that representatives from eleven universities came together in August 1975 on the campus of the University of Delaware to form an organization called the National Consortium for Computer-Based Music Instruction (NCCBMI). Its specific goals are:

> First, to provide a forum for the exchange of ideas among developers and users of computer-based systems for music instruction; second, to establish and maintain a library of music courseware; third, to reduce redundant effort among courseware and hardware developers; and fourth, to provide consultation for new users of computer-based music instruction. (Hofstetter, 1976, p.30)

The NCCBMI is a special-interest group in the Association for the Development of Computer-Based Instructional Systems (ADCIS) and holds its annual meeting in the same location. NCCBMI panels and exhibits are now an annual part of the College Music Society, Music Educators National Conference, and Computer Music Association meetings. NCCBMI members provide consulting services and hold workshops for persons just starting out in the field. NCCBMI publishes a bimonthly newsletter in which members share ideas and are informed of meetings and new hardware and software products on the market. The organization also publishes an annual courseware directory providing detailed information about the leading CBI courseware in the country. On a quarterly basis, ADCIS publishes the *Journal of Computer-Based Instruction*, a refereed journal, one issue of which is devoted exclusively to music CBI articles. Persons interested in more information concerning NCCBMI should contact Michael Arenson, Department of Music, University of Delaware, Newark DE 19716.

REFERENCES

Arenson, M.A. (1982). The effect of a competency-based program on the learning of fundamental skills in a music theory course for non-majors. *Journal of Computer-Based Instruction, 9,* 55-58.

Arenson, M.A. (Ed.). (1983). *1983 NCCBMI Courseware Directory.* Newark, DE: University of Delaware Central Duplicating.

Arenson, M.A. & Hofstetter, F.T. (1983). The GUIDO® system and the PLATO® project. *Music Educators Journal, 69,* 46-51.

Benward, B. (1978). *Ear Training: A Technique for Listening.* Dubuque, IA: William C. Brown.

Boody, C.G. (1983). Microcomputers and music: An overview of the hardware capabilities. Paper presented at the meeting of the College Music Society, Dearborn, MI, November 1983.

Canelos, J.J., Murphy, B.A., Blombach, A.K., & Heck, W.C. (1980). Evaluation of three types of instructional strategy for learner acquisition of intervals. *Journal of Research in Music Education, 28,* 243-249.

Diehl, N.C. & Ziegler, R.H. (1973). Evaluation of a CAI program in articulation, phrasing, and rhythm for intermediate instrumentalists. *Council for Research in Music Education, 31,* 1-11.

Eddins, J.M. (1978). Random access audio in computer-assisted instruction. *Journal of Computer-Based Instruction, 5,* 22-29.

Hofstetter, F.T. (1975). GUIDO: An interactive computer-based system for improvement of instruction and research in ear training. *Journal of Computer-Based Instruction, 1,* 100-106.

Hofstetter, F.T. (1976). Foundation, organization, and purpose of the National Consortium for Computer-Based Musical Instruction, *Journal of Computer-Based Instruction, 3,* 21-33.

Hofstetter, F.T. (1981). Applications of the GUIDO system to aural skills research. *College Music Symposium, 21,* 46-53.

Simpson, P. & Goodwin, A. (1984). Computer presentation of acoustic spectrum patterns as an aid in teaching music performance skills. Paper presented at the meeting of the Association for the Development of Computer-Based Instructional Systems, Columbus, OH, May 1984.

Taylor, J.A. (1982). The Medici melodic dictation computer program: Its design, management, and effectiveness as compared to classroom melodic dictation. *Journal of Computer-Based Instruction, 9,* 64-73.

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Language Authoring with "Comet"

Wolfram Burghardt

Like other authoring systems, COMET attempts to circumvent what is surely the single major obstacle to efficient production of instructional software: the complex and immensely time-consuming nature of computer programming. Basically, there are three avenues open to the pedagogue who wishes to develop a computer-based course.

If he is ambitious, he will want to custom-program his material, using a *high-level computer language* such as APL or BASIC. However, this approach poses major problems. Very few teachers acquire the necessary programming expertise, while the mind set of the professional programmer can sometimes lead to a dehumanization of instructional methods. Even if this problem is solved through teamwork, it may take weeks to program a lesson that will keep the student working for an hour. The CLEF project at the University of Western Ontario has shown that, in the field of language instruction, custom programming can indeed produce excellent results, but only if generous funding is available.[1]

A second avenue is provided by *authoring languages* expressly designed for the creation of computer-assisted learning (CAL) material. My own experience with this approach dates back to 1977, when the University of Western Ontario Language Laboratory linked up with a PDP-10 mainframe for a pilot project in CAL. The Italian text I was using at the time seemed to beg for computer support, and ETL, an authoring language developed at the university, helped to provide the answer. This took the shape of an "electronic workbook" delivered to the student via teletype. Although the limitations of ETL were reflected in the program itself, and the teletype interacted with the student in a monotonous flow of line after printed line, the course worked surprisingly well. The one-to-one tutorial relationship with the machine fulfilled a real need that could not be met in the classroom and seemed to have particular appeal to two special groups: problem learners requiring extra practice and gifted linguists in search of perfection. Students carried home reams of printout, often feeling that they had brought their linguistic problems under control.

By the end of the second year of experimentation, it had become clear that human ingenuity could stretch, but not breach the limitations inherent in the ETL/teletype combination. Some of the alternative authoring languages, like PILOT, offered ease of programming at the expense of power, while others, like NATAL (a mainframe-based language, developed in the Seventies by the National Research Council of Canada), promised impressive power at the expense of simplicity. Furthermore, they did not cater to the specific needs of language learners. Constance E. Putnam puts the problem in a nutshell when she says "we should be unwilling to make do with second-hand authoring languages developed initially for other disciplines, which do not

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really fit our needs".[2]

A third avenue is provided by so-called *authoring systems*, which do not require the coursewriter to learn a computer language or to acquire specialized programming skills. Sitting in front of his machine, the author merely responds to a series of questions about his pedagogic strategy and types in the subject material, laying out the text on a blank monitor screen. On the basis of this information, the system builds an instructional program from a set of ready-made routines. Compared to the use of a high-level computer language or even the most rudimentary of authoring languages, the savings in development time are dramatic.

Very few of these systems have been designed for the exclusive purpose of language instruction. Their unstructured frame-by-frame approach to course design, a major strength in the vast majority of subject areas, imposes too many repetitive decisions and uneconomic tasks on the language author who usually works with more predictably patterned learning sequences. Answer-processing routines and the handling of text on the screen often have to be upgraded by a professional programmer to satisfy the specific demands of language instruction.

These are some of the considerations that led me to design my own microcomputer-based authoring system. In broad terms, the system aims to achieve a radical economy in course-development time and to cater exclusively to the specialized needs of language instruction.

The Template Concept

The acronym COMET stands for "COmputerized Modular Exercise Templates." The term "template" is used here to designate a driver program containing a pre-established instructional pattern. Functioning solely as a delivery vehicle, it exists separately from the subject material to be conveyed. This separation can be physical, with driver program and instructional files residing on separate disks. Such a pre-programmed system frees the coursewriter from reinventing teaching strategies and grappling with display problems, so that he may devote all his efforts to the development of pedagogic material.

The legitimate objection can be raised that simplicity and productivity have been purchased at the expense of locking the author into a predetermined pattern. COMET deals with this problem by offering not one, but several different templates, most of which can be customized by adding or subtracting a variety of optional features. Thus the problem of rigidity is transformed into a question of form. To draw an analogy from the field of literature, let us consider traditional versification. A Baroque poet, for instance, rarely invented his own verse forms. Instead, he chose from a large array of available patterns: the octave, the tercets, the sonnet with its possible variations in rhyme scheme and so forth. Some of these metric "templates" had a wide range of usefulness, others were more suitable for specific purposes, but all were characterized by excellence of design. Handled with talent and imagination, they could be a highly effective poetic tool.

Modularity

COMET is a menu-driven system made up of interconnected programs and data files. Modular design allows large portions of a program to be lifted out and utilized in the creation of new templates. Modifying a few language-specific routines and implanting a new set of messages makes it easy to produce parallel versions for other foreign languages. The COMET package currently exists in four such variants: French, German, Italian and Spanish (all designed for English-speaking students). Russian is being contemplated and other language combinations can be added as required.

Exercise Patterns: Common Features

In its present stage of growth, COMET is slanted toward interactive language practice rather than the imparting of information. A typical exercise sequence begins with a free-form *orientation frame*, which the coursewriter

lays out with the help of a blank-screen editor. A useful vehicle for creating a situational context or for presenting a review capsule, the orientation frame is supported by a help screen. The student holds down the [?] key to view this screen, which the author may use for reformulating or translating his explanations. The help frame can easily be set up as an overlay so that paradigms can be held over on the screen, while the explanatory material shifts from one language to the other.

The first frame of the exercise sequence functions as a *model frame.* Conceptually it illustrates the type of linguistic operation the student is expected to perform. Visually it uses highlighting (reverse video) and movement of letters to simulate the keyboard operation involved: pressing a number key for multiple choice, selecting an item from a list, filling a blank or transforming a word. The coursewriter using the screen editor needs only to key in the text and provide the expected answer; the formatting and the dynamic displays are pre-programmed.

A sequence of interactive *work frames* follows. In the COMET system these need not be synonymous with single questions, for the author is free to vary the rhythm of his sequence by loading a frame with as few queries as he wishes or as many as space will permit. The traditional sentence-by-sentence approach can be abandoned in favor of dialogues or narrative passages. To set up a work frame, the coursewriter lays out the text on the screen and tells the computer how many queries the frame contains. For each successive query the computer prompts him to supply a cue (if applicable), the expected answer, alternate answers (if the response is to be typed out), two distractors (if a multiple choice format is used), a branching label (if supplementary frames are utilized) and optional adjustments of error handling.

In a final *evaluation frame* the student's responses are broken down into four categories: right on first try, answered with help, corrected, wrong. Bar graphs, with raw scores and percentages indicated, help to visualize the statistics.

Passive-Skill Exercises

By far the simplest of the COMET templates is a quick-paced *Vocabulary* program. A word list, which the coursewriter may organize under a series of subheadings (for instance, parts of speech), is automatically formatted and displayed by category. As the student keeps pressing the [+] key, successive items are momentarily highlighted and then checked off as being known. If he encounters an unknown word or expression, the student presses the [?] key to receive a translation. Although this program could conceivably stand alone, it is intended as a support option, linked to a specific exercise.

Multiple Choice "3" is also fairly simple in its concept. For each successive query, a three-way choice appears in a message area at the top of the screen, while the textual material is displayed in the work space below. The student makes his selections with a single keystroke and the computer merges the correct answer into the text displayed on the screen.

Slightly more complex, *Multiple Choice "9"* prints a list of up to nine items, which is held over from one frame to the next.[3] This pattern works particularly well with sets of uninflected words (Fig. 1) and can also be used for grammatical or semantic matching exercises.

Active-Skill Exercises

We are all too familiar with the write-in exercise, where the expected answer is often embedded in a linguistic context. The COMET version of this ubiquitous all-purpose pattern has the same visual layout as Multiple Choice "3," with an optional cue displayed in the message area (Fig. 2). With its variety of optional features, to be discussed later, this pattern is truly the workhorse of the COMET system.

A *multi-cue* version of the write-in pattern provides up to nine different cues, which remain on the screen throughout the work cycle (cf. Multiple Choice "9"). A student caught on the wrong semantic track is invited and ultimately helped to pick the appropriate cue from the list.

Only then will he make another attempt to produce the grammatically correct form. More complex and more challenging to the learner than the single-cue version, this type of exercise is well suited for working with small groupings of inflected words.

Exercises in the Planning Stage

New, more specialized templates will be added to this nucleus of basic utility patterns. High on the planning list is a program that will generate Cloze-type exercises, which require the student to reconstruct a text in which every *n*th word has been blanked out. Unlike printed Cloze tests, the COMET version will be dynamic in allowing the learner to set his own degree of difficulty, as he would in playing computer chess. Asking for every fifth word to be deleted would create a very difficult exercise, having every twelfth one removed a fairly easy one. In a departure from the original Cloze concept, the user will also be able to focus on a particular problem by asking the computer to blank out a certain part of speech. One student might want to work on verbs, another on articles and adjectives, a third on prepositions. In short, the machine will custom-edit a pre-coded base text, creating a wide variety of exercises to meet individual needs.

Even more urgent is the need to develop templates where typing is replaced by the manipulation of larger units of language. The simplest program will display two scrambled lists of phrases or half-sentences which have to be correctly matched. A second template could be described as a tagmemic "construction set." It will enable the author to present a target structure graphically in the form of a box pattern with a choice of lexical items in each of its fields. These items will then be combined by the student to form a number of meaningful and grammatically correct sentences. A third template will allow authors with a penchant for maze design to set up a guided composition pattern in which the student is required to construct one of several possible stories by choosing between alternative paths.

Response Fields

Numerous options are available to the coursewriter as he inputs his lesson material. When he sets up a sequence of work frames, one of his first choices involves the use of response fields, that is, sections of a line reserved for the student's answer.

Instead of using the standard *blank,* the author may type a series of graphic characters to represent the physical *shape of the answer.* Thus a ••'•••.•• ••• •'••• pattern would help the beginner to produce a complex multi-word response like "qu'est-ce que c'est." In semantically oriented work a shape-of-the-answer field can also be a useful device to filter out unwanted synonyms.

A third type of response field can be created by highlighting a word or a phrase which is to be typed over by the learner. This is the obvious choice for transformation exercises, for instance a present tense narration that is to be rewritten in the past.

On the screen, response fields are supported by features reminiscent of word processing. Text will move apart during typing to make room for a longer answer or, on the contrary, close in around a short response that is found to be correct. Even though response fields may move around within a line, the cursor will correctly skip to the beginning of the next field, as the student progresses from query to query. What matters here is the psychological reality of actually working within a context and visibly modifying that context, rather than producing independent linguistic forms.

Help Features

While attempting to produce an answer, the student may call for help by pressing the [!] key. As pre-selected by the coursewriter for the given exercise, help will arrive in one of three forms.

The first help feature switches the current question to a *multiple choice* format. The student no longer needs to produce the correct

answer: it will be sufficient to recognize it.

An alternative feature replaces the blank by the *shape of the answer,* generated automatically by the computer. This is particularly helpful when the student is expected to produce a structure consisting of several words.

The third help feature, *letter-feed,* can be best explained through an example. Let us assume the student loses his bearings halfway through typing an answer and presses the instant-help key. If he has already made an error, his unfinished answer is rolled back as far as necessary and the next correct letter is fed in. Each help call will produce another correct letter until the student has regained his orientation.

With three help features to choose from, the author no longer needs to devise long lists of "useful hints," a dubious task in language work, where students' problems are varied and unpredictable. Help features also reduce the number of wildly wrong answers that are sent to error analysis routines. It is known that these routines function best when the student's response is preponderantly correct.

Since the COMET system gives all feedback messages and evaluations in the target language, an instant *translation* service is provided for the benefit of the novice. A beginning student can be easily puzzled by feedback like "Sind Sie auf der richtigen Spur? Wählen Sie das passende Stichwort!" If that is the case, he merely needs to hold down the [?] key to see the message instantly replaced by "Are you on the right track? Pick the appropriate cue!" As soon as he releases the key, the original message is restored.

Answer-Processing

One of the more fascinating aspects of CAL programming is answer-processing, in which, at the simplest level, the student's response is checked against the expected answer to arrive at a right/wrong evaluation. At the other extreme, the response can be processed by diagnostic routines of varying complexity. Here James P. Pusack distinguishes three main approaches: (a) pattern markup (as in PLATO or his own DASHER), (b) error anticipation (common to most authoring systems) and (c) machine parsing (too complex to be implemented on a personal computer).[4]

COMET's answer-processing, internally similar to the pattern markup approach, stresses simplicity and reliability. First of all, many mechanical errors are filtered out at the source by disabling non-alphabetic keys and catching common infractions of basic typing conventions before they reach the screen. Upper/lower case errors are ignored as the student's response is compared with the anticipated answers. (Some of these may have been tagged by the author as "less desirable," i.e., correct, but not what was really expected.) If no match is found, a comparison routine tries to determine which of the anticipated answers the student was attempting to produce. On that basis the response can be judged to be incomplete, to be incorrect or to contain a minor error. In the latter case it is sent to a further analysis routine which is able to distinguish between:

one character wrong,
one character short,
one character too many,
a double instead of a single letter,
a single letter in place of a double,
two letters switched.

Since the routine makes further distinctions between letters, spaces, hyphens and apostrophes, and recognizes the presence or absence of accents and other diacritical marks, the computer is able to construct precise messages, which nudge the student towards a successful correction.

Sound, Light and Motion

On the screen, errors are handled by a set of routines utilizing sound, light and motion. Wrong parts of an answer are rolled back and correct completions rolled in, accompanied by a series of discreet tones running up or down the C major scale. Text is audibly split open or jammed together to eliminate a wrong space. An incorrect character lights up and drops

through the bottom of the screen with a falling note. Transposes letters are rotated into position to a Kodaly motif familiar to space film buffs. When an error can be corrected by a single keystroke, an undulating cursor appears in the problem location and prompts the student to complete the answer. Upper/lower case errors are the last to be dealt with and are corrected with a sound-and-light effect, unaccompanied by verbal comment. None of this is intended as direct emulation of arcade games. Rather, sound is used in a functional way to focus the student's attention on what is happening on the screen when corrections are performed by the machine.

Looping

A linear learning sequence can be rendered more flexible by looping. The student working on a COMET exercise will see this technique operating on two levels. Every failure to produce a correct answer on the first attempt generates an invitation to try again. At the end of the exercise, a statistical breakdown of performance is coupled with the invitation to "try for 100%." On acceptance, the program loops back to the beginning and recycles the appropriate frames, which have meanwhile been re-edited by incorporating previous correct responses. In short, the student arrives at the correct response through trial, error and discovery, a process that is central to any kind of learning.

Branching

A more radical way of breaking the Skinnerian pattern of a programmed learning sequence is provided by branching. A coursewriter favoring intrinsic (non-linear) strategies can make quick-learning students speed through a brief version of an exercise, while slower learners are directed to supplementary frames. Some of the COMET templates allow the author to design expandable exercises in which the branching switch is tripped by a failure to make a correct multiple choice or to produce a correct answer on second attempt. All the coursewriter needs to do is indicate the number tag of the supplementary frame that is to be activated in such an event. Although there are no design restrictions on branching paths and the author can nest his supplementary frames like Russian dolls, the memory limitations of the personal computer impose a quantitative ceiling of twenty interactive frames per exercise.

Personalization and Gender Matching

At the beginning of every work session, a personal file card is filled out on the screen. This is how the system obtains the user's name, surname and title (Mr., Mrs., Miss), from which sex is determined. With this information stored, the computer may occasionally address the student by name and will always use the proper gender agreement.

This kind of personalization can easily be extended to the exercise itself. In this case, gender agreement in expected answers will be adjusted, wherever appropriate, to fit the student's sex. Usually this will involve the first person singular and, more rarely, plural. Compare the Russian "Ja vernaul*as*' usta*laja*" or the Italian "Siamo stat*e* fortunat*e*." In fact, entire exercises can be devised on this basis. To give students practice with "parts of the human body," one might compose a passage about "my ideal type," specifying male-female alternatives throughout.[8] Before delivering the text to the student, the computer checks the personal data stored and makes the required changes. No unusual coding is demanded from the coursewriter, who, in a different context, might type something like: "Nous étions tou(/te)s amoureu(x/ses) de ce(tte/) jeune (fill/homm)e." The program takes care of the rest.

If the exercise is in dialogue form, the student's name can be edited into the text or used as a dramatis persona. This allows the author to set up a situation in which the learner is asked to act out a particular role. (See Fig. 2, where student Jane Doe plays a tough customs officer in Marseille.) Not only does role playing make for livelier and more meaningful language practice; new structures can be presented as functions of situational contexts, personal attitudes or types of human interaction. Six easily remembered variable names

allow the coursewriter to seed his text with the user's title, name and surname in upper or lower case, as required.

Verbal Feedback

Wilga Rivers echoes the observations of many teachers involved in CAL, when she writes:

> Students working with carefully constructed computer programs do not seem to experience the feeling of isolation and depersonalization that some expect. ...corrections and comments on students' specific weaknesses and misunderstandings create the feeling of a dialogue with someone who is intensely interested in them personally.[6]

To enhance this human-to-human feeling, COMET uses a friendly, conversational, supportive style of verbal feedback. When commenting on performance, the computer rarely uses the same wording twice in a row. For each of the eighteen message types, there is a list of interchangeable wordings. Little used messages may have two or three variants, frequently used ones as many as ten. At the beginning of an exercise, each of these lists is shuffled like a deck of cards. As work progresses, messages are picked up in this randomized order to simulate the spontaneity of human conversation.

The COMET Filer

To conclude this description, let us put the coursewriter's task in perspective. The beginning of this article described a template as a driver program delivering a set of instructional files. Now a third component must be added, the filer program used to convert pedagogic material into correctly structured disk files.

COMET's menu-driven set of filers enables the author to set up a *course menu*, a series of *lesson menus* (both automatically formatted) and, at the base of the pyramid, *exercises* of different types. The exercise filers combine the freedom of blank-screen editing with the reliability of step-by-step prompts. With capsule instructions displayed for each step and with added orientation panels available on request, the coursewriter or his clerical help are safely guided through the stages of creation and revision.

Courseware: Work in Progress

COMET is being used at present to develop a number of language courses, mostly at the University of Western Ontario.

I myself am working on a first-year Spanish course consisting of situationalized dialogues and narrations. Developed with the help of Fatima Martins, a graduate assistant funded by the UWO Department of Spanish and Italian, a first draft of this 22-lesson course is already receiving extensive use.

Christa Burghardt, who had authored some 20 lessons for the University of Western Ontario CLEF project,[7] has now written 200 situationalized exercises covering the French Core Program, prescribed in Ontario schools. Her course, designed to complement the two most popular textbooks used, is now being field tested.

We are presently utilizing COMET to develop an intermediate French course for first-year university students. A preliminary draft of the course is already in use.

Finally, the department of German and Russian are seeking funds for similar projects.

Hardware: PET 4032 and CMD 8032

The COMET system has been developed on successive generations of the Commodore PET with the current version running on a Model 4032 (32K) with 12-inch screen. The CBM 8034 (a business model with 80-column screen) can also be used. Commodore's character generator chip has been replaced by a 4K EPROM containing the original fonts plus two additional character sets: French-Italian and German-Spanish. Three programmed keys, [/] for the acute, [\] for the grave and [↑] for all other diacritical marks, enable the student to produce a total of 28 foreign characters by overstrike. A protection key, plugged into the cassette port, is part of the DTL system used to compile

COMET programs, which are too large and complex to run in their BASIC version.

While development work is done on a CBM 4040 dual floppy disk drive, the UWO Language Laboratory runs COMET on a mini-network sharing a D 9060 single hard disk drive through a MUPET control device. Other CBM disk drives supporting BASIC 4.0 can also be used.

Conversion of COMET to the Commodore 64 color computer is under way.

Conclusion

From the language teacher's point of view, authoring languages and systems have always had two major drawbacks: flexibility and simplicity of use seemed to exclude each other, and features specific to language instruction were not included in the design. COMET's template collection with its variants for individual languages attempts to deal with these problems. The present package of high-utility programs has proven its worth in a university context by making it possible to create-full-year language courses at relatively modest cost. Since a lesson of five exercises, containing from 10 to 20 questions each, can be input by a careful typist in one working day, the term "development" has once again become synonymous with the creative process of designing pedagogic material.

Future work will concentrate on incorporating user suggestions for improvement and creating new, specialized patterns to enhance the methodological versatility of the system.

NOTES

1. Glyn Holmes, "Creating CAL Courseware: Some Possibilities," *System* 11(1) (1983), 21-32.
2. Constance E. Putnam, "Foreign Language Instructional Technology: The State of the Art," *CALICO Journal* 1(1) (1983), 36.
3. The split-screen feature is standard in all COMET templates.
4. James P. Pusack, "Answer-Processing and Error Correction in Foreign Languages," *System* 11(1) (1983), 53-64.
5. This has been done by my student assistant Fatima Martins in the framework of a course in elementary Spanish.
6. Wilga M. Rivers, *Teaching Foreign Language Skills*, second edition (The University of Chicago Press, Chicago and London, 1981), p.115.
7. Glyn Holmes and Marilyn Kidd, "The CLEF Project: Learning French on Colour Micros" in *Computer Literacy, Intelligent CAI: Conference Proceedings* (ADCIS, Bellingham, WA., 1982), pp.245-251.

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The Challenge for Computer-Assisted Rhetoric

Hugh Burns

Rhetoric today is more than "the counterpart of dialectic," as Aristotle defined it in *The Rhetoric.* It is more than the art of persuasion, more than a speaker's appeals based on credibility, logic, and emotion. Scholars and critics like Kenneth Burke, Kenneth Pike, Francis Christensen, Lloyd Bitzer, Wayne Booth, Roman Jakobson, Thomas Kuhn, Charles Peirce, Noam Chomsky, and James Kinneavy have further defined and elaborated structures and procedures for creating and understanding thought manifested as language. Consequently, the study and the teaching of rhetoric have changed, and will change even more because of the astonishing developments in computer science, electrical engineering, and optical physics, to mention just a few "new" technologies."

Still, some things do not change. Many humanists still resist the technology, and often rightly so. This resistance is not new. In fact, in the second lecture of his 1885 *Discourses in America,* Matthew Arnold defends literary studies against the predominance of nineteenth-century practical scientific knowledge. He concludes with one of those timeless pieces of Victorian rhetoric:

> And a poor humanist may possess his soul in patience, neither strive nor cry, admit the energy and brilliancy of the partisans of physical science, and their present favour with the public, to be far greater than his own, and still have a happy faith that the nature of things works silently on behalf of the studies which he loves, and that, while we shall all have to acquaint ourselves with the great results of science, and to give ourselves as much training in its disciplines as we can conveniently carry, yet the majority of men will always require humane letters; and so much the more, as they have the more and greater results of science to relate to the need in man for conduct, and to the need in him for beauty.

Arnold argues convincingly that the humanist faces an even greater challenge than the scientist of relating the results of scientific and technological discovery to humankind's needs for appropriate behavior and aesthetic understanding.

At this minute, that challenge remains viable. Moreover, although I question whether patience is necessarily the best tactic for articulating these connections, I am convinced that humanists today first have to carry "conveniently" so much more technology in order to relate its more and greater results well and accurately. That Arnold's words were actually written for *The Nineteenth Century* in August of 1882 and delivered to an American audience over one hundred years ago does not diminish their present challenge to those of us in humanities education. Indeed his idea challenges all of us as teachers of rhetoric in an emerging fifth-generation educational system.

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Thus, the humanist who studies rhetoric today should be a student of cognitive psychology, linguistics, anthropology, philosophy, and computer science, and probably more. This poor, necessarily eclectic humanist who teaches rhetoric should be capable of presenting and modeling the heuristic processes for creating human discourse as well as the hermeneutic processes for understanding human discourse—all the time acknowledging, if not exalting, their mysterious recursive relationships. So how does a modern rhetorician "conveniently carry" or conveniently teach anymore?

One answer, it seems to me, comes in the wise use of computer-assisted instruction in both assisting the production and the comprehension of personal discourse. The key, again it seems to me, is designing, programming, evaluating, and improving recursive CAI in three of the rhetorical canons: invention, arrangement, and style. By recursive CAI, I mean computer-assisted instruction that presents tools for creating and simultaneously understanding the written or spoken products. CAI in rhetoric should make users not only better writers and speakers but also better readers and listeners. If I find software that accomplishes these goals, then I have something worthwhile. The electronically inclined rhetorician should be able to conveniently tote a small computer and a box of humanistically programmed disks.

This article will illustrate what I believe will be possible and will comment on a few critical assumptions for such future computer-assisted rhetorical software.

Beginnings

What might a computer program say to a writer about writing? To begin at the beginning, one might program an opening sequence in the following manner:

> GOOD MORNING, TODD. MY GOODNESS, YOU ARE UP BRIGHT AND EARLY; YOU MUST BE READY TO WORK OR ELSE YOUR DEADLINE HAS FINALLY MADE YOU FEEL GUILTY ENOUGH TO WRITE. TELL ME HOW I CAN HELP YOU.
>
> DO YOU JUST WANT TO COMPOSE? OR DO YOU WANT ME TO HELP YOU BRAINSTORM, ORGANIZE, STYLE, EDIT, OR PROOFREAD? PERHAPS CALL UP ONE OF YOUR DATA BASES?
>
> MY GUESS IS THAT YOU NEED TO COMPLETE THAT PIECE FOR ROBERTA ON THE NATIONAL EDUCATION ASSOCIATION'S PROPOSED ENDORSEMENT FOR QUALITY SOFTWARE.

Such an opening sequence would require "knowing" several data items about the writer, Todd, about his normal uses for the computer, about what the writer has already done on the system. The program, since it had no menu, would also have to be able to understand whatever the writer said or typed next. In other words, the program would know what time it is, have a model for this writer's behavior and notice variations in personal habits, know that it can provide five basic rhetorical services in addition to being a word-processing package, and be able to estimate from the data in memory that a particular file is due for a particular audience on a particular topic. Most of these features could be programmed today.

For the program to contain this information, however, the writer would have to define the rhetorical specifications for each of the files, probably through a series of computer-prompted inquiries. In every word-processing package I'm familiar with, a writer who opens a text file is asked to name that file. At that point, sets of rhetorical questions could prompt the writer to define the audience (e.g., Roberta), the basic topic (e.g., National Educational Association's Proposed Endorsement for Quality Software), the deadline or due date, and perhaps even the assignment of the writer's personal priority (e.g., a number between one and ten). Such information would then be available for each of the opening sequences once the author enters the electronic writing tutor program. In these queries, the program is explicitly getting to know the writer. Let's return to the hypothetical run to see how this might work.

The choices Todd has at this point are (1) composing or word processing, (2) brainstorming, (3) arranging information, (4) styling, (5) editing, (6) proofreading, or (7) researching. For each of these possibilities, keep in mind how each category can be enhanced both explicitly and implicitly to direct the composing process intelligently. The writer can be asked for specific information, or the program can attend to and capture information about the writer's fluency (i.e., keystrokes per minute), revision approaches via ratios (i.e., word level versus sentence level), or readability ranges (i.e., approximate education level of the audience). The strategies for offering the writer this implicitly gathered, empirical information would vary depending upon what individual writers say they need or, perhaps, what their teachers would like the writer to consider. This implicit information could thus be compiled and used to satisfy an expressed need for such a detailed analysis. So the word-processing packages for composition or rhetoric teachers would have the capability to request rhetorical information up front and to analyze the prose accordingly.

Word Processing—The Rhetorical Opener

If our writer, Todd, continues this sequence by requesting to open a file, what might happen through explicit prompting? (Note: The user's remarks are italicized.)

THANK YOU, COMPUTER, I NEED TO OPEN A NEW DOCUMENT FILE THIS MORNING.

OKAY. WHAT DO YOU WANT TO NAME IT?

WESTART

WOULD YOU LIKE TO COMPLETE THE RHETORICAL SITUATION ANALYSIS?

YES

WHO IS THE AUDIENCE?

THE DIRECTORS OF THE MUSEUM OF WESTERN ART.

WHAT APPROXIMATE EDUCATIONAL LEVEL DO YOU WANT TO ACHIEVE IN TERMS OF READABILITY?

11.5

WHAT IS YOUR BASIC TOPIC AREA?

THE OPENING OF THE O'KEEFFE EXHIBIT

WHAT DEADLINE DO YOU HAVE TO COMPLETE THIS TEXT?

FEB 26

WHAT IS YOUR PURPOSE?

TO WRITE THE PROGRAM ANNOUNCEMENT TO EXPLAIN HOW THE O'KEEFFE EXHIBIT WAS ORGANIZED AND WHAT THE DIRECTORS HOPE TO ACCOMPLISH WITH THE WESTERN ART SERIES THIS YEAR.

WILL YOU WANT TO MOVE ILLUSTRATIONS, TABLES, OR FIGURES FROM THE GRAPHICS MODULE?

NOT YET, BUT ASK ME THIS AGAIN.

FINE, TODD. IS THERE ANYTHING ELSE YOU WANT ME TO INCLUDE IN A REMARKS SUBFILE BEFORE I TURN YOU OVER TO THE WORD PROCESSING SOFTWARE?

NO

The advantages of such a "front end" to a word-processing package are basically assembling a rhetorical profile for each file if the author so desired. In an instructional package, such a front end would illustrate to the writer or speaker that creating discourse is based on certain assumptions about audience, situation, time, and purpose. At this point, Todd would be branched to the compatible word-processing package.

Word-Processing—Toward the Intelligent Interaction

How most writers envy the natural writer whose prose flows at an even rate of sixty-plus words a minute for periods of thirty minutes at a time. The decision to interrupt such a writer's fluency would be foolish. However, what if a writer is not fluently writing? What strategies might a computer program designed for use in a writing lab be able to do? In a personal writing conference, a teacher seeing that a writer is

blocked could respond according to prior experiences with that particular writer. The difficult part for that teacher is knowing how to diagnose the block. The same dilemma would confront the intelligent word-processing package. Is the idea falling apart for lack of just the right word? Is the writer trying to remember what supporting argument to include next? Has the writer decided to reorganize the introduction? Or has the writer's motivation simply ebbed for the time being? What would such an interaction with a computer look like?

FINE, I'LL BRING UP WONDER-FULL WORD. IT WILL TAKE ME A FEW NANO-SECONDS; PLEASE BE PATIENT.

DO YOU WANT THE HELP MENUS DISPLAYED?

NO

DO YOU WANT ME TO REMAIN INTERACTIVE?

YES

FINE, HOW DO YOU WANT ME TO DECIDE TO INTERRUPT YOUR WRITING? IN OTHER WORDS, WHAT LEVEL OF INTERACTION WOULD YOU PREFER? I CAN TIME YOUR WRITING BLOCKS, RANDOMLY PROMPT, EVALUATE CORRECTNESS FOR EACH SENTENCE OR AFTER EACH PARAGRAPH, OR WAIT FOR YOU TO ASK ME A QUESTION ABOUT YOUR TEXT.

LET ME KNOW EVERY FIVE MINUTES HOW MANY WORDS I HAVE WRITTEN. RUN A SPELLING AND USAGE CHECKER EVERY FIFTEEN MINUTES. LOAD "ART QUOTATIONS" BECAUSE I'LL NEED TO TRANSFER SOME OF MY RESEARCH TO THIS PROMO.

OKAY. ART QUOTATIONS: 4 PAGES, 10 ENTRIES AVAILABLE. PRESS RETURN TO ENTER WESTART FILE.

The writer then begins to enter the text, and the interactive program is to do no more than what was requested. Some writers are curious about their pace; others are not. Some writers may prefer catching their spelling or jargon as they write; others may prefer to wait until the file is completely written and ready to be proofread. Some writers may prefer to have their research notes on cards instead of in electronic files. The point of an intelligent word-processing interaction is to give the writer what is wanted when it is asked for. Theoretically, after considerable experience with such an interactive program, the writer could judge which functions helped the most and set up the operational protocols accordingly.

In using such a tool in the teaching of composition or speech, a teacher would have to decide what aids to activate at what specific points in the course. For the first lessons, there might be no analysis except the fluency rates so that issues of correctness were put off until a certain fluency rate was achieved. The teachers, of course, by submitting a text to computer-assisted diagnostic routines that the writers would not see interactively could selectively give feedback when the novice writer was the most receptive. Worrying too early about correctness inhibits the unleashing of the ideas. The point is that such interactive writing works only when the interactions are tailored to the writer either by the writer or by a teacher who has determined a sequence of writing prompts that will help the writer learn more about his or her discourse production.

Electronic Brainstorming

Great promise is offered by the capability of a computer to ask questions, to explain and sometimes demonstrate heuristic strategies, and to prompt and catalog writers' ideas. The potential for rhetorical invention on a computer to enhance the composing process can be illustrated by a few template programs. Open-ended inquiries using three of the more formal heuristic methods—Aristotle's topics, Kenneth Burke's pentad, and Young-Becker-Pike's tagmemic questioning have shown two satisfying results: that many writers significantly increased the number of ideas about their respective topics and that their ideas tended to offer more sophistication, more surprise value, and often more breadth. Helen Schwartz,

William Wresch, Lillian Bridwell, Valarie Arms, Raymond Rodrigues, Dawn Rodrigues, Ruth Von Blum, and Cynthia Selfe are several researchers exploring for better ways to implement invention software.

As these programs are augmented with intelligent responses about the content areas and as natural language understanding is added, such programs will continue to improve. The areas of expertise may have to be designed and implemented slowly, but the potential is there for a conversational expert to interact on-line with a writer.

How might such a dialogue begin?

THANK YOU, COMPUTER. I NEED TO BRAINSTORM THIS MORNING.

HOW DO YOU WANT TO PROCEED? I CAN ASK QUESTIONS. DEPENDING ON YOUR TERMINAL, I CAN DRAW CLUSTERS FOR YOU AND THEN YOU CAN LABEL AND LINK THEM.

ASK ME SOME QUESTIONS.

WHAT KIND OF QUESTIONING STRATEGY SHOULD I USE? ARE YOU TRYING TO PERSUADE, ENTERTAIN, OR INFORM?

INFORM

WHAT NOUN PHRASE SHALL I DROP INTO THESE QUESTIONS AS YOUR TOPIC?

O'KEEFFE'S ARTISTRY

FINE, O'KEEFFE'S ARTISTRY IT IS THEN.

I NOTICE YOUR TOPIC HAS TWO WORDS. SEE IF YOU CAN COME UP WITH A LIST OF THINGS OR IDEAS THAT COULD BE USED TO DESCRIBE O'KEEFFE'S.

SHEER LANDSCAPES, BONES, VACUOUS EYES, THIN, DESOLATE LANDSCAPES, FLOWERS, DRIED, FRAGILE, SYMBOLIC REPRESENTATIONS FOR HARSHNESS, DEATH RATTLES ON CANVAS, INDIAN GEOMETRICS

THE SECOND WORD WAS ARTISTRY. SEE IF YOU CAN LIST THINGS OR IDEAS THAT PERTAIN TO ARTISTRY.

CRAFTFUL VISION, INSIGHT, BEYOND THE CANVAS TO FEELING AND MEANING, AN ABILITY TO CREATE ART, AN ABILITY TO MAKE WORTHY ART, SENSES OF PURPOSE AND BALANCE, REALIZING IN FACT OR ARTIFACT WHAT ACTUALLY IS REPRESENTED IN THE IMAGINATION, MAKING REAL.

GOOD, TODD. ANYTHING ELSE?

NO

I WANT YOU TO MAKE SOME CONNECTIONS BETWEEN THE TWO LISTS NOW. I NOTICED YOU SAID DEATH RATTLES ON CANVAS ON THE FIRST LIST. CAN YOU COMBINE THAT IDEA WITH SENSES OF PURPOSE AND BALANCE ON THE SECOND LIST. THIS IS JUST AN EXAMPLE. YOU MAY WISH TO COMBINE TWO OTHER ITEMS. IF YOU CHOOSE TO DO THAT, IT WOULD BE FINE WITH ME.

I KEEP THINKING ABOUT THAT ONE BULL SKULL AND IT SEEMS TO ME TO BE A DEATH RATTLE ON CANVAS—WITHOUT SOUND. AS IF ITS PURPOSE WERE TO WARN A VIEWER ABOUT BALANCE IN LIVING. NOT UNLIKE THE MOMENTO MORI IDEA AS A MATTER OF FACT, A WESTERN FOLK RELIGION AS IT WERE REPRESENTED ALL AROUND US BY THE WESTERN ARTIFACTS AND HARSH LIVING.

SAY, YOU APPEAR TO BE ON A ROLL HERE. DO YOU WANT TO ADD SOMETHING ELSE?

NO

ARE THERE DATES OR CHRONOLOGICAL EVENTS THAT YOU CAN TELL YOUR AUDIENCE ABOUT WITH REGARD TO O'KEEFFE'S ARTISTRY?

YES, I WILL HAVE TO DO A LITTLE MORE RESEARCH THERE.

RESEARCH IS ALWAYS A GOOD IDEA. WE MAY BE ABLE TO USE ONE OF OUR ON-LINE BIBLIOGRAPHIC SERVICES.

WHY NOT LIST SOME OF THE THINGS YOU'LL NEED TO LOOK UP?

HER EDUCATION, HER FIRST SHOWINGS, HER BACKGROUND, HER FAMILY, HER ARTISTIC DEVELOPMENT, HER WRITING ABOUT HER ARTISTRY, HER MOTIVATIONS FOR PAINTING.

WHAT WOULD BE THE MOST SURPRISING IMAGE TO YOUR AUDIENCE OF DIRECTORS OF THE MUSEUM CONCERNING O'KEEFFE'S ARTISTRY?. . . .

Such a brainstorming exercise helps writers gather information about the range of ideas they can actually write about. Again, the point is not to make a writer dependent on the computer for offering the brainstorming techniques, but to model how some writers actually begin to think about their various topics. Eventually, such invention programs will be tied to the data bases themselves, where they will be found even more useful.

No writer can write well indefinitely without ideas generated by some such brainstorming scheme. Besides, most writers are more fascinated with their own creativity than with the often more tedious work of arranging and polishing the ideas. But the work of arrangement will also be helped along through computer-assisted rhetoric.

Electronic Arrangement

One of the characteristics of good writing is a recognizable pattern subtly delivered so that the ideas find their meaning enhanced in discourse systems—both at the sentence level and particularly beyond the sentence. One of the most troublesome characteristics of teaching rhetoric is seeing the regrettably lean pedagogy for teaching patterns of arrangement. Certainly, there are patterns beyond the sentence outline, the five-paragraph theme, and enumerative order that may be more appropriate and more enriching for writers to practice.

Also, the computer-assisted arrangement ought to allow for choices. Suppose our writer now elects to begin arranging the information he has gathered about "O'Keeffe's Artistry."

TODD, ARE YOU STILL WRITING TO INFORM?

YES

FINE, THEN I WILL ASK YOU TO THINK ABOUT THE PARTS OF YOUR ESSAY. ARISTOTLE WAS CONVINCED THAT YOU SHOULD STATE THE IDEA FIRST, THEN SUPPORT IT. NOW ALTHOUGH HIS WORDS PERTAIN SPECIFICALLY TO PERSUASION, WE CAN USE THEM TO THINK ABOUT HOW YOU WILL MANAGE TO SAY JUST WHAT YOU WANT YOUR WHOLE ESSAY TO SAY.

WHAT IS YOUR CENTRAL IDEA FOR YOUR ARTICLE ON O'KEEFFE'S ARTISTRY?

TO GIVE THE MUSEUM'S PATRONS THE BACKGROUND INFORMATION THEY WILL NEED TO ENJOY AND TO BETTER APPRECIATE THE O'KEEFFE EXHIBIT

WHAT DO YOU MEAN BY BACKGROUND INFORMATION?

I MEAN HOW GEORGIA O'KEEFFE'S LIFE AFFECTED HER ART AND WHAT SHE WAS TRYING TO SAY.

CAN YOU LIST A FEW SUPPORTING PREMISES FOR WHAT YOU JUST WROTE?

YES

OKAY, THEN YOU MAY WISH TO JOT THEM DOWN HERE. LIST AS MANY AS YOU CAN. WHEN YOU ARE FINISHED, PLEASE PRESS THE RETURN OR ENTER KEY.

PREMISE ONE: WHAT HER PARENTS WERE LIKE

PREMISE TWO: HER FIRST PAINTINGS

PREMISE THREE: HER FIRST SHOWINGS AND THE REACTIONS TO HER FIRST SHOWINGS

PREMISE FOUR: DESCRIBING ONE OF THE PAINTINGS

PREMISE FIVE: [Return]

WHAT EVIDENCE COULD YOU BRING TO BEAR ON ONE OF THESE PREMISES THAT MIGHT BE INTERESTING TO THE MEMBERS OF YOUR AUDIENCE?

WHICH PREMISE DO YOU WANT TO SUPPORT FIRST?

3

OKAY, NOW WHAT IS YOUR SUPPORTING STRATEGY? IN OTHER WORDS, WHAT COULD YOU DO AS A WRITER TO STRENGTHEN THE IDEA? YOU MAY WANT TO GIVE AN EXAMPLE, OR YOU MAY WANT TO WRITE DOWN SOMETHING YOU HAVE FOUND IN YOUR RESEARCH.

I COULD FIND ONE OF THE REVIEWS OF HER EARLY SHOWINGS AND THEN TRY TO FIND OUT WHAT HER REACTION WAS TO SUCH EXHIBITS AND THE REVIEWS.

COULD YOU USE ANY OF THE PREMISES AS EITHER THE ENTRANCE OR THE EPILOG FOR YOUR ARTICLE?

YES

PLEASE EXPLAIN.

I COULD USE AN OLD FAVORABLE REVIEW TO SAY HERE WE GO AGAIN —O'KEEFFE'S UNIQUE VISION STILL CAPTIVATES EXHIBIT GOERS AND THIS EXHIBITION WILL BE NO EXCEPTION

ANY MORE?

NO

IF YOU BEGIN WITH SUCH A PREMISE, THEN WHAT WILL YOU DO NEXT? WHAT COULD FOLLOW THIS OPENING THAT WOULD HELP THE READER SEE WHAT WAS GOING TO FOLLOW?

I COULD USE A FLASHBACK TO SHOW HER CONSIDERING THE THINGS SHE WANTED TO ACCOMPLISH WITH HER ART, MAYBE USE AN EXCERPT FROM ONE OF THE INTERVIEWS OR FROM ONE OF HER PERSONAL DESCRIPTIONS OF THE ARTISTIC PROCESS.

OKAY, LET'S REVIEW WHAT YOU HAVE TOLD ME SO FAR. I WILL DO SOME NUMBERING OF THE IDEAS YOU HAVE TYPED IN. YOU WILL BE ABLE TO CHANGE THEIR ORDER, DELETE, ADD. FOR EVERY STATEMENT YOU KEEP, I WILL ASK YOU TO WRITE AT LEAST ONE MORE SENTENCE THAT YOU MAY ELECT TO USE IN YOUR ARTICLE.

Such an arrangement dialogue would result in a kind of ordering that should match the purpose of the article and the sense of the subject. The rest of the dialogues could develop the classical modes such as narration, description, cause and effect, comparison and contrast, etc. The final result would be a composition plan, that is, a promising order for the ideas that could be considered. Everyone knows that the final order of a mature piece of prose usually evolves in the writing. How dull it would be to be surrounded by just one pattern for discourse, for example, the five-paragraph essay. Lots of challenges are awaiting the electronic rhetorician in formulating the best ways to teach arrangement interactively.

Electronic Stylistics

The study of style often relies too much on analyses of someone else's language. Although I believe that reading and sometimes even copying exercises are useful ways to illustrate choices at three levels. In word, sentence, and text, computer-assisted stylistics is again best performed on one's own writing with control of the final words, sentences, and overall style belonging exclusively to the individual. The program I envision would concern itself again with some upfront analysis of an author's stylistic intentions.

WHAT STYLISTIC RANGE DO YOU THINK WOULD BE MOST APPROPRIATE FOR YOUR AUDIENCE: FORMAL, MIDDLE, INFORMAL?

A MIDDLE STYLE—NOT TOO INFORMAL

WHAT ARE SOME OTHER DESCRIPTIONS FOR HOW YOU WANT READERS TO REACT TO YOUR WRITING? CHOOSE SOME OF THE FOLLOWING WORDS: WARM, COLD, ABSTRACT, CONCRETE, OBJECTIVE, SUBJECTIVE, LITERAL, SYMBOLIC, ACADEMIC, BUSINESS.

ACADEMIC, YET WARM. OBJECTIVE.

At this point, the program would "read" the text and analyze it accordingly. Like many of the workbench programs, the program would identify readability levels, percentage of abstract terms, number of passive voice constructions, number of *be* verbs, number of expletive sentence openers, number of *which* and *that* constructions, and—among others—the most frequently seen words. Also, such programs would offer suggestions like using *hopefully* well, avoiding *the fact that*, checking uses of *principal* and *principle*, etc.

The programs then should be able to help with improving writing on line. Perhaps the program could identify a sentence with some possible weakness, diagnose it on the spot, and allow the writer to craft a new sentence and insert it in the text at that point.

I HOPE YOU WON'T MIND MY SUGGESTING A FEW SENTENCES THAT MAY NEED SOME SPECIAL ATTENTION BECAUSE THEY DID NOT MATCH THE CRITERIA YOU HELPED ME DEFINE—A MIDDLE STYLE, ACADEMIC, WARM, OBJECTIVE.

SHOULD I CONTINUE?

YES

SINCE YOU ASKED, HERE THEN IS AN EXAMPLE FROM YOUR ARTICLE:

IT HAS BEEN DETERMINED THAT GEORGIA O'KEEFFE IS A VERY GIFTED ARTIST WHO SPECIALIZED IN STILL LIFE PAINTINGS.

WOULD THE FOLLOWING SENTENCE BE TIGHTER?

GEORGIA O'KEEFFE IS A GIFTED ARTIST WHO SPECIALIZED IN STILL LIFE PAINTINGS.

MY POINT IS THAT YOU HAVE DELAYED THE MAJOR POINT OF THE SENTENCE WITH THE OVERUSED OPENER, "IT HAS BEEN DETERMINED." THE WORD "VERY" IS OFTEN OVERUSED. NOTE THAT THIS SENTENCE STILL HAS A FORM OF THE VERB, "TO BE." CHECK TO SEE IF THIS SENTENCE CAN BE COMBINED WITH THE FOLLOWING SENTENCE.

HOW WOULD YOU LIKE THIS SENTENCE TO READ NOW?

A GENUINELY GIFTED OBSERVER, GEORGIA O'KEEFFE MADE THE WESTERN STILL LIFE EVEN MORE STILL.

I THINK YOUR NEW SENTENCE IS BETTER FROM THIS POINT OF VIEW. I DID NOT FIND A FORM OF THE VERB, TO BE. YOU MUST HAVE USED A MORE ACTIVE VOICE. GOOD.

NOW WOULD YOU CONTINUE WRITING THIS SENTENCE BY REPEATING AN IDEA, A WORD, OR PERHAPS A PHRASE. TRY IT.

A GENUINELY GIFTED OBSERVER, GEORGIA O'KEEFFE MADE THE WESTERN STILL LIFE EVEN MORE STILL, AND IN THAT STILLNESS WE CAN SHARE HOW HARSH THE WEST WAS FOR HER AND—THROUGH HER ARTISTRY—FOR US.

Eventually, computer-assisted style should draw a writer's attention to the rhythm of the prose, alliteration and various other sound structures, and even a variety of syntactic arrangements. And after calling attention to the stylistic possibilities, a computer-assisted rhetoric lesson should provide the opportunity learning that final forms are polished, cared for, and always consciously attended to.

The Final Goal: Intelligently Directing Rhetorical Processes

Three major propositions in the concept of "intelligently directing the composing process" can be reached by focusing our research and development efforts on three separate issues: the nature of intelligence, the nature of directing or teaching the production of text, and the nature of the composing process itself. I don't want to argue that these three efforts are mutually exclusive, but I do want to propose that each area offers enough educational challenge that our research efforts can at first be distinct. The fact is that many writers already ackowledge how useful these computing machines can be in the writing process. For example, I was amused by Arthur C. Clarke's final acknowledgment in his *2010: Odyssey Two:* "This book was written on an Archives III microcomputer with WordStar software and sent from Colombo to New York on one five-inch diskette. Last minute corrections were transmitted through the Padukka Earth Station and the Indian Ocean Intelsat V." What would Matthew Arnold think of such a technology for the production and transmission of prose? Would Matthew Arnold have acknowledged his quill?

So the notion of conveniently carrying as much training in science as we can, actually may mean some inconvenience for the humanist simply because the complexities of our information age are greater. The technology promises so much, but the promises themselves must be realized in our need for conduct and in our need for beauty. So much the more as we have the more and greater results of this new and (one day soon) intelligent tool. What will finally emerge from the artificial intelligence laboratories will be intelligent systems that have the capability to understand concrete domains and make inferences. These labs may also unravel the non-trivial problem of comprehending a natural language used in context. What will finally emerge from the learning research and development centers will be models of individual learning and sets of articulated strategies for learning. What will emerge from the composition research will be protocols describing what actually happens in the writer's mind as discourse is recursively invented, arranged, styled, remembered, and delivered. Arnold's challenge remains: so much the more... The immediate work for rhetoricians in instructional technology should integrate these diverse discoveries for the purpose of humanistically designing, developing, and producing an intelligent computer-assisted tutor of rhetoric—an electronic Socrates.

REFERENCES

Aristotle. *The Rhetoric and the Poetics of Aristotle.* New York: Modern Library, 1954.

Arnold, Matthew. *Prose and Poetry.* Edited by Archibald Bouton. New York: Charles Scribner's Sons, 1927.

Boden, Margaret A. *Artificial Intelligence and Natural Man.* New York: Basic Books, 1977.

Burns, Hugh, and George Culp. "Stimulating Invention in English Composition through Computer-Assisted Instruction." *Educational Technology,* 20 (August 1980), 5-10.

Burns, Hugh, "A Writer's Tool: Computing as a Mode of Inventing." In *The Writer's Mind: Writing as a Mode of Thinking.* Edited by Janice Hays, et al. Urbana, Illinois: NCTE, 1983.

Clarke, Arthur C. *2010: Odyssey Two.* New York: Ballantine Books, 1982.

Kiefer, Kathleen E., and Charles R. Smith. "Textual Analysis with Computers: Tests of Bell Laboratories' Computer Software." *Research in the Teaching of English,* 17 (October 1983), 201-214.

Kinneavy, James L. *A Theory of Discourse: The Aims of Discourse.* Englewood Cliffs, N.J.: Prentice-Hall, 1971.

Lindemann, Erika. *A Rhetoric for Writing Teachers.* New York: Oxford University Press, 1982.

Nold, Ellen. "Fear and Trembling: The Humanist Approaches the Computer." *College Composition and Communication,* 26 (October 1975), 269-273.

Schwartz, Helen J. "Monsters and Mentors: Computer Applications for Humanistic Education." *College English,* 44 (February 1982), 141-152.

Wresch, William. "Computers in English Class: Finally Beyond Grammar and Spelling Drills." *College English,* 44 (September 1982), 483-490.

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Generic or Specific: Having it Both Ways with Generative CAI

Gerald R. Culley

As computer-assisted instruction (CAI) in foreign languages emerges from its infancy and tries to achieve recognition as a serious instructional technique, two distinct approaches are in evidence. The one, in which a designer focuses on one subject and one textbook, may be called the specific approach. It is characterized by "hard coding" of questions and answers in a format which is closely and exclusively tailored to one application. The other, which may be called the generic approach, attempts to reach a wide range of users who may be at different levels in language study and be using different textbooks. The strengths and weaknesses of the two approaches examined in this essay will also suggest a method for combining them without loss of breadth or precision.

Generic programs are attractive for many reasons, not the least of which is the savings in development costs that can be realized when programs with wide application are produced. Only three years ago, the cost of computer hardware was a major concern; the dramatic drop in hardware prices since then has forced a new perspective on the public. Now it is software that is expensive. Some buyers have found to their dismay that the first major piece of software they would like to acquire actually sells for more than the computer on which it is to run. In such an environment, users would like to spend their software dollars on fewer programs that do more rather than on a seemingly endless succession of single-purpose routines.

A generic program seems to satisfy this desire. It supports not just one chapter of a textbook, but the whole book. Better, it supports not just a single textbook, but a whole series (e.g., German I-III). Best of all, it will be usable for several different series of textbooks on the same subject (e.g., Elementary German). Students will not run a series of forty or fifty different half-hour programs on one subject in a year of study, but will spend an equivalent amount of time on a few programs, perhaps only one.

The saving in development costs here is obvious. If programs are broad enough to cover a whole subject area and even conform to different textbooks, the CAI students' need can be produced with much less investment of money and effort. The saving realized should, in fact, make it feasible to produce multiple versions of the programs for different machines, and thus make good CAI still more widely available.

More efficient use of resources also allows the programs written to be of the highest possible quality. If fewer programs are being developed, it is possible to do more extensive testing and debugging on each one. More time can be spent on the hard-to-define but vital quality of design. Designers can give more attention to legibility and intelligibility of the screen displays, and the flow of a program can be more rigorously thought out.

With efforts concentrated on a relatively small number of carefully designed, meticulous-

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ly executed programs, students will benefit. Not only will they enjoy programs that run well from a technical standpoint, but they can appreciate the aesthetic superiority that comes from extra care. Beyond this, a given student will spend more time with any one program, become accustomed to its format, learn to use it, and be freed to concentrate on its subject matter and not its mechanics. Like a purchaser of a pocket calculator, he will acquire enough familiarity with the format to forget that and begin using the program as a tool to attack the subject matter.

Since the advantages of generic programs are so obvious, one would expect authors to write nothing else. That they do not implies the existence of impediments. In reality, there is only one, but it is crippling.

The critical weakness of generic programs is that, in trying to fit all approaches, they fail to provide much real instruction. The field of language teaching illustrates this problem vividly. Different textbooks employ differing vocabulary and varying approaches to grammar and syntax. Even where the same vocabulary items are found, they are often introduced in different order; students begin meeting words in the program which may not appear in the textbook for several more chapters. This problem of order applies to grammar as well: the textbook may introduce tenses in the order present—perfect—future while the program uses present—future—imperfect—perfect. The inescapable result is that if a program fits textbook A well enough to be a useful supplement, it will be hopelessly inappropriate for textbook B. Designers have tried to avoid this problem by reducing the linguistic content of the programs and concentrating on culture and history; but so long as *any* material in the target language appears in the CAI program, compatibility remains a problem.

The designer of a program is, in fact, faced with a dilemma. All of the considerations mentioned in the first part of this essay argue for a program that is generic. Yet the attempt to write such a program breeds frustration. Anything specific, anything really helpful to the student, limits the usefulness of the program with some textbooks and instructors. Those who teach languages find this a familiar problem; they have seen it in the audio-visual materials publishers provide. Either these materials are closely keyed to one textbook (and thus useless whenever one changes texts), or they are designed merely as "enrichment" and are therefore hard to integrate into the curriculum. In the latter case, they incur the risk of being judged irrelevant to the teacher's goals.

Many, perhaps most, of the generic language programs now commercially available are vulnerable to the charge of irrelevance. One such is "Alicia: A Spanish Bilingual Reader," a Spanish program (Earl, 1981) that uses the story of *Alice in Wonderland*. Students read a few lines of the story in Spanish, then respond to questions about it. Text and questions may be presented in either English or Spanish. A student using the program soon runs afoul, however, of the problems of vocabulary, grammar and syntax mentioned above. In effect, a student who knows enough Spanish to make progress through the program does not need the help it offers.

Another, more ambitious, generic language program is "Mystery House" (Williams, 1980). This is a popular adventure game in which the user explores a mansion by typing commands for the computer such as "go south," "climb stairs," and "read note." Along the way he encounters obstacles, dangers, corpses, and clues to the mystery. When French is used for both the displayed text and for the student's typed commands, the game can become a learning experience. The excitement of unraveling the mystery motivates the student to read the French of the displays and to use French verbs and nouns at the keyboard. He must reach a fairly advanced level before he can understand the French text displayed, and the commands to be typed allow him to practice only a few verbs and nouns. With enough French, one may play the game with relish, but it is questionable how much language is being learned. Despite the promise of this technique, it is limited in its usefulness to "enrichment."

When seen against this background, specific CAI programs have obvious virtues. They are

by their nature integrated into a curriculum and move in step with it. Keyed chapter-by-chapter to a given textbook, they will never introduce a vocabulary item too soon or inflict an advanced construction on an unprepared student. The designer of such programs can include as much review as desired, since he knows exactly what has been taught up to a particular point. He may, if he likes, even refer to specific pages of the textbook and individual illustrations. Finally, the fact that specific questions are asked means that the designer can predict answers with some accuracy and arrange for specific feedback.

All of this, however, must be balanced against the fact that the specific program fits only one textbook—indeed, most often it fits only one small portion of one textbook. To go on beyond these narrow limits the designer has to begin another program. This limitation has been keenly felt by those who have designed language programs for microcomputers. With the exception of the textbook publishers (who have some reason to view it differently), few designers have been willing to accept so severe a restriction on the appeal of their work. One finds few textbook-specific programs.

A simple response to this problem has been to pretend that it does not exist. Some of the most ambitious programs, such as "Micro-Deutsch" (Comito and Russell, 1982), present the material they consider appropriate and assume that teachers will find ways to incorporate it into the curriculum. Where the material is soundly conceived and sensibly presented, as with this program, teachers are likely to make the attempt, but it is a difficult and frustrating endeavor.

Another approach has been to separate the driver of the program from the content and so achieve some flexibility. On the simplest level this approach has given us numbers of vocabulary-practice programs.[1] The flexibility, though real, is almost the only quality that commends these programs. They are essentially electronic flashcards, doing a traditional task in a more expensive manner.

A more ambitious application is the Spanish series by Robert Phillips (1981). It includes charts of verb forms and types of verbs, explanatory text and helps, and other useful elements to produce something much more than a simple vocabulary drill. These refinements have produced a more useful educational tool, but to the extent that they include non-editable elements of grammar they restrict the program's value in real classroom situations.

More ambitious still is DASHER, by James Pusack (1982). More than simply a program, this has often been called an authoring system for foreign language instruction. It permits instructors to insert their own exercises which the system will then manage for them. The student's response is compared with the answer specified by the instructor and a diagnostic markup is provided, with misspellings, incorrect word order, and omitted words all flagged. Foreign characters and accents may be used. The instructor may also stipulate whether a student need type the entire answer again after an error, or just the incorrect portion. This is one of the best attacks yet on the generic-specific dilemma; Pusack has crafted a program that will accept questions and answers for any foreign language, but capable of very specific markup when students answer incorrectly. For example, the task may be to convert a statement into a question, substituting a pronoun:

Cue: The neighbors are fighting again.
Response: Are they fighting again?

A student may type: They are fightng again?
DASHER responds: (You have the right words in the wrong order.)

Are -- fight-ng again?
-- *they*

This is a powerful technique for instruction. It has few rivals on microcomputers.

Even so, the system has serious deficiencies. Its markups are purely mechanical; that is, it makes no attempt to comment on the language features of the student's response. Another task, such as typing the Latin equivalent of an English verb phrase, will illustrate this fault.

Cue: We were walking.
Student types: ambulabatis
DASHER responds: Incorrect.
ambulaba--s

The two incorrect letters here, -ti- for -mu-, are

identified by the program; but what is not noted is that the error was almost surely conceptual, not mechanical. The student has typed the equivalent of "you were walking." DASHER does not take note of the language as language.[2]

To have both the wide applicability of a generic program and the language-oriented, textbook-compatible treatment of a specific program, something more is needed. That something is generative CAI,[3] a technique in which the computer is made to produce the questions and answers that the student is practicing. For languages, this means teaching the computer how to inflect the variable parts of speech and "know" the grammatical identity of each form. This approach is especially well suited to the highly inflected languages (such as Latin, Finnish, German, and Classical Greek). Though it sounds difficult, it is not especially so; about two years ago a popular computing magazine published the complete listing of a program to conjugate any regular Latin verb. The program was written by a high school student (Lippman, 1982).

A generative program has many benefits, as an example from Latin will show.

1. A vastly expanded number of exercises can be generated without corresponding increases in the memory requirement. Since the computer inflects the forms on demand, a small database of stems has maximum impact. A program on noun-adjective phrases with 100 noun bases and 80 of adjectives yields 8,000 possible pairings, each of which may appear in one of ten forms (five cases, singular or plural). There is therefore a potential for 80,000 drill items.
2. Much more sophisticated judging of student answers and feedback on partially correct ones. A program that can conjugate a verb can be made to separate a student's typed verb into stem, tense/mood sign, and personal ending and comment on it in those terms. The following examples illustrate some of the power of the technique.
   a. Give the Latin for "We were walking."

Student Types	*Computer Responds*
*ambal*at	The stem is wrong.
ambul*abit*	Check the stem vowel/tense-mood sign.
ambulaba*t*	The personal ending is wrong.

   b. Give the Latin for "She will hear."

Student Types	*Computer Responds*
audibit	Fourth conjugation verbs don't use -bi- in the future.
audiemus	The form you typed is FIRST person PLURAL future active indicative.

   c. Give the Latin for "He has been helped."

adiuta est	The form you typed is third person singular perfect passive indicative, FEMININE gender.

   The pedagogical potential of such morphemic analysis is obvious.
3. "Invisible" review, i.e., the capability to review missed forms by presenting, three or four items later, not the item that was missed, but a similar one. For example, a student misses **muniebat** in the drill. Three items later, by giving him **dormiebat**, the computer reviews the missed concept (third singular imperfect active indicative of the fourth conjugation) rather than the item. Such review is often invisible to the user, and thus more effective, but it can only be done if the program "knows" the grammatical identity of the items presented.

The key element here is that the program contains a logical model of the language's inflectional pattern. Consequently it can provide the individualized services which are characteristic of a "specific" program while still retaining the virtues of a generic one.

The University of Delaware's Latin Skills Program illustrates this technique. Begun nearly eight years ago on the mainframe PLATO[4] system and now converted to micro format for the Apple II computer, this series focuses on morphology, sentence translation, and parsing of Latin words in context (Culley, 1978, 1980, 1982). The two programs on verbs contain routines that can produce (and therefore, recognize) all forms of regular verbs in Latin. A third program provides similar coverage for the regular nouns and adjectives.

A fourth, on translation of Latin sentences, can tell a student the grammatical form, dictionary entry, English meaning, and function in context of every word in every sentence the student is to translate. Students are encouraged to interrogate the computer about any word or words they like before attempting to translate. The fifth program, which deals with parsing, responds to an error in parsing by simply taking the student's input (e.g., third plural, imperfect passive subjunctive verb) and inflecting the stem with those instructions. The student is then shown what the form would look like if his identification were the correct one. To accomplish this, the program must be able to inflect all regular nouns, adjectives, pronouns, and verbs in the language, together with several common irregulars. It therefore has the potential to produce millions of discrete forms.

The Latin Skills Program is able, then, to provide very specific feedback for partially correct answers, but it is also a generic program. The five driver programs described above are independent of the actual exercises they contain, and the exercises typically consist of sets of word stems or bases with grammatical identifiers. For example, an English-to-Latin verb exercise item would be stored like this: (they have been seen/vide vid vis 2 6 4 2 1). The three stems of the Latin verb are followed by grammatical identifiers: conjugation 2, person/number 6, tense 4, voice 2, mood 1. The driver takes these data and handles all the rest—inflecting the verb, determining if the student has typed any legitimate form of the target verb, even using animation, upon request, to assemble the appropriate form one morpheme at a time.

It is obviously more difficult to construct such driver programs than to "hard code" questions and answers. But the dividend is seen not only in the ability to provide precise diagnostic and corrective feedback, but in the ability to substitute whole new databases of exercises at will. The Latin Skills Program has four such databases now, each one keyed directly to one Latin textbook; ultimately it will have seven. Once the drivers have been designed, coded, and tested thoroughly, they can easily be made to work with a wide variety of textbooks, and they perform with each textbook as if they had been designed originally for it alone.

This approach pays dividends also in the amount of use a student obtains from each program. Although the Latin Skills Program consists of only these five formats, it delivers from forty to sixty hours of instruction for each student. Each time a student returns to a given program throughout the year, more challenging material is encountered. After the first session, the format of the program is familiar, and attention can be centered on the subject matter. The program becomes a sophisticated tool for attacking the problem of language learning.

If CAI is to reach its potential, designers will have to produce programs of high quality, at a substantial investment of resources, including time. To be cost-effective, these programs must combine the virtues of generic and specific approaches. Generative CAI is one technique which will permit designers to have it both ways.

NOTES

1. Here are a few:

C.E. Howerton (1981). Foreign language drill I. Diskette for Apple II. Marck, 280 Linden Avenue, Branford, CT 06405.

Robert C. Clardy and Charles J. Fleishman (1982). The linguist. Diskette for Apple II (48K). Published by Synergistic Software, 5221 120th Avenue S.E., Bellevue, WA 98006.

Al Clark (1980). Italian/German vocabulary drill. Diskette for Apple II (48K). Published by Powersoft, Inc., P.O. Box 157, Pitman, NJ 08071.

Latin package. Four diskettes or cassettes for PET, Commodore 64 or Apple II. Part I has 200 nouns; II has 175 verbs; III has 75 numbers, colors, months, etc.; only Part IV is editable by the user. Published by Island Software, which has a similar package for French. Queue, 5 Chapel Hill Dr., Fairfield, CT 06432.

2. It should be recognized that Pusack is aware of this fact and has chosen to avoid basing the program's judging algorithm on linguistic features. He did this partly to avoid the difficulties inherent in the linguistic approach and partly to make the program applicable to a variety of languages simultaneously (Pusack, 1983).

3. The technique of generative CAI has been employed by several persons. The first of which this writer is aware was Weller (1976), who applied it to the Spanish verb.

4. PLATO is a registered trade mark and service mark of Control Data Corporation.

SOFTWARE REFERENCES

Comito, Joann and John Russell (1982). Micro-Deutsch. Diskette for Apple or PET. Published by Krell Software Corp., 1320 Stony Brook Road, Stony Brook, NY 11790.

Earl, George (1981). Alicia: a Spanish bilingual reader. Diskette for Apple II (48K). Published by Opportunities for Learning, 8950 Lurline Avenue, Dept. 26CD, Chatsworth, CA.

Phillips, Robert (1981). Practicando Español con la manzana II, part I (verb drill) and part II (vocabulary drill). Diskette for Apple II (48K). Published by CONDUIT, P.O. Box 388, Iowa City, IA 52244.

Pusack, James P. (1982). DASHER: a natural-language answer processor. Diskette for Apple II. Published by CONDUIT, P.O. Box 388, Iowa City, IA 52244.

Williams, Ken and Roberta (1980). Mystery house. Diskette for Apple II. Published by Sierra On-Line Systems, Inc., 36575 Mudge Ranch Road, Corsegold, CA 93614.

PRINT REFERENCES

Culley, Gerald (1978). Computer-assisted instruction and Latin: beyond flashcards, *Classical World* 72, 393-401.

——— (1980). When PLATO knows Latin: benefits of letting the computer inflect the forms, Proceedings of the Association for the Development of Computer-Based Instructional Systems (Washington, D.C.), 237-240.

——— (1982). A computer-aided study of confusion in Latin morphology, in Linguistics and Literacy, ed. by William Frawley, published by Plenum Publishing, New York, 239-254.

Lippman, David (1982). Computo, computas, computat, *Microcomputing* March, 1982, 136-139.

Pusak, James P. (1983). Answer processing and error correction in foreign-language CAI, System II (1).

Weller, Hubert P. (1976). An experiment in computer assisted instruction in elementary Spanish, Proceedings of the 1976 Conference on Computers in the Undergraduate Curricula (SUNY-Binghamton, 1976), 281-287.

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Designing Instructional Materials for the Humanities: Is There a Role for Interactive Videodisc Technology?

Michael DeBloois

According to Hoekema (1983) learners "make choices affecting the pace and sequence of the presentation. This capacity for interaction between user and system allows information delivery to be tailored to individual users through a careful blend of system controls and direct user controls." Bunderson (1983) claims that there must be "a conversational exchange. The user responds through some input device and through decision logic, one or more selections from the library of video materials is displayed."

In recent articles I have attempted to add to the understanding of the concept by describing interactive instruction as a videodisc-based system with the following characteristics:

1. Users create unique lesson sequences based on their own interest and learning style by selecting from hundreds of pre-planned options.
2. As learners make selections, the system responds with appropriate feedback, instructional sequences or additional options to provide the user with materials appropriate to their (a) interest, (b) ability, (c) learning style preference, (d) pace, (e) language.
3. Materials are encoded on the disc in a modular rather than linear form. This is described as a matrix design (DeBloois, 1982).
4. The lesson is created as the result of a genuine interaction between the learner and a data base of visual, textual and audio cues recorded on optical and magnetic memory.

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Implications for Designers of Instructional Materials

Now that we have identified what is meant by interactive instruction, let's move on to the implications this concept holds for instructional developers in the humanities.

In the view of most developers, their role requires the application of systematic thinking to the design of instructional materials. In the organization of learning events, activities and media, we select models representing our view of how learning occurs. We design information systems based on cybernetic principles. Frequently electronic technology is the communication vehicle through which messages are delivered to learners. But have developers really looked at the implications of individualizing instruction for learners? We are all very comfortable and enjoy the role we are playing; it is an important role, but not critical. We are "part" players, with other people performing the leading roles, assuming the greatest responsibility, taking the most "heat."

Suddenly, two publications appear and seem to upset everything. Both are alarming; one, *A Nation At Risk,* because it fails to even recognize that we exist. Instructional developers are neither part of the problem nor hope for the solution. The other, *Mega Trends,* is alarming because we are forced to confront the tremendous role we must now assume as information specialists in a new information society.

A Nation At Risk acknowledges conditions in public schooling which designers of learning materials have been predicting and attempting to remedy for more than two decades, yet its recommendations suggest answers which hark

back to the good old days which, in reality, never existed. The blue ribbon panel responsible for this publication was able to complete its study with scarcely a hint of the importance of instructional technology as a means of instructional improvement, even though instructional designers believe that high-quality, validated instructional systems may be the only way we will ever deliver better learner performance in less time and at lower per-learner cost. Have we indeed made so faint a mark upon the face of public and private training and instruction?

Naisbett, the author of *Mega Trends*, on the other hand, opens the door to the future and the view we see confirms phenomena we each personally have observed, but had difficulty articulating:

> Our nation's greatest resource is information.
>
> The economic reality today is that we have already changed from an industrial state to an information society.
>
> We are, however, drowning in information, but starved for knowledge.
>
> Someone must grapple with our problem of uncontrolled information (information pollution). We need information technologists to bring order to chaos and give value to otherwise useless data.
>
> Just at that moment in history, when our nation has its greatest need for the products of our schools to be highly skilled, we are, for the first time in our history, producing a generation of learners who are less skilled than their parents.

It is in this context that we must examine the implications of interactive instruction in the humanities. If the trends that Naisbett identifies are accurate, and we indeed are becoming a high tech, high touch, decentralized, self-help, multiple-option society, people who develop training and educational systems must put away their old "industrial revolution" tools, and learn to use new ones more appropriate to emerging trends. We are told that in the future, students who are unable to function with a computer will be illiterate, helpless and impotent. This statement is probably not true. The long haul will see user-friendly ergonomic systems emerge to prevent such a situation. In the short haul, however, it is we early and mid-career adult educators who will be displaced, as surely as Detroit has cold winters, if we lack computer and other high-tech abilities. Computers will not replace a single teacher or instructional designer, but teachers and instructional designers who use computers may replace those who do not.

Principles for Action

Three implications of these mega trends are offered to developers of instructional products in the humanities.

First, as a principle for action, remember that yesterday is over, but tomorrow isn't going to last forever, either. We must become comfortable with change. Flexibility and adaptability should become our watchword. Usefulness in the past does not insure present appropriateness nor future reliability. Figure 1 symbolizes the type of instruction most of us encountered during our formal education. Linear lessons directed by others, designed for some average student somewhere, who never existed, representing the golden mean for whom all reading levels were selected, lessons paced, and instructional styles developed.

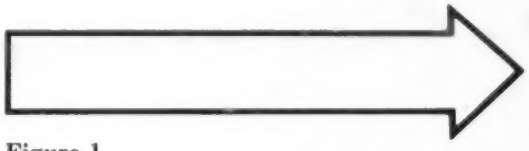


Figure 1

Figure 2 represents the type of non-linear lesson which may now be developed using interactive formats with the help of computers and videodisc players. Here each learner selects that particular sequence, style, pace, format, level of sophistication, and medium which is felt to be most appropriate or relevant.

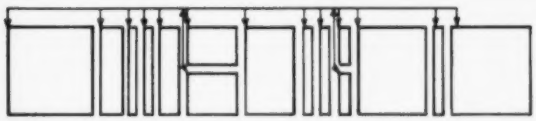


Figure 2

Naisbett describes recent changes in the publishing industry. National publications such as *Life, Time,* or *Der Stern* were formerly assumed to meet the needs of a vast audience of subscribers. Today, however, publishers have shifted from a forced-supply mentality to one of user selection. Hundreds of new publications have sprung up addressing individual interests ranging from weight-lifting to IBM PC computer use. Do you have a particular hobby or interest? There is a magazine available covering that topic. The same phenomenon has occurred in radio-listening, television-viewing, clothing, selection, automobile-purchasing, selecting a church congregation, food-shopping, and so on. Like it or not, our society has changed from one built around the imaginary needs of the "average individual" to one in which individuals demand that their particular wants and needs be fulfilled. Education has been one of the strongest hold-outs, and the next most likely bulwark of an earlier era to crumble.

According to Ralph Tyler, you can tell that you are being educated if your options are increasing; the reverse is happening if they are decreasing. Interactive instruction increases the options for learners, giving them control over all the key variables of learning. It also increases the options for the designer of learning materials, providing heretofore unknown opportunity to create exciting new activities for the learner, activities which implement models we have come to believe in about the way people learn.

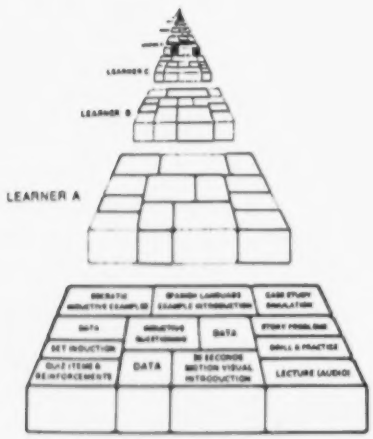
Built upon the first, the second principle is that the advancement of computer technology and its peripherals (optical laser discs) will force designers of instructional systems in the humanities and in other disciplines to adopt new objectives, new models, and new methods. In his book *Technological Change,* Emmanuel G. Mesthene states:

> The argument in brief is that new tools . . . create opportunities to achieve new goals or to do things in new ways. This means that people and groups of people generally must organize themselves differently in order to take advantage of the opportunities offered by new tools . . . . Technological innovation therefore leads ultimately to a need for social and political innovation if its benefits are to be fully realized and its negative effects kept to a minimum.

With recent development of interactive videodisc/microcomputer technology, those of us who develop instructional systems for a living have had thrust into our hands a remarkable learning technology. When compared to other technology advances of only a decade ago, the advancement is quite unbelievable. Imagine a learning tool which can store up to 1.25 billion bytes of read-only memory on the optical disc, and add to it the randomly accessible memory of the magnetic disk (between 64 and 256 kilobytes in most applications), and you have a very dense information-storage medium. This medium can store information in almost any form. It offers the developer the opportunity to flexibly select, in a variety of patterns, a medium of instruction for learner use. If you wish, thousands upon thousands of pages of text and graphics could be drawn from either the computer or videodisc. Or the data base could be organized to provide text and color slides, or text, color slides, motion video and sound. Or if you like, combinations of motion video, color images and up to 400 hours of stereophonic audio could be called up. All images or audio messages are randomly accessible within less than a three-second search. These 400 hours of audio could be arranged to provide identical messages related to video images in two, ten, or 100 languages simultaneously, if the designer faced this need. To the technology, the computer adds "intelligence" which allows the designer to create intelligent lessons for learners. These lessons may simply present information which increases the learners' knowledge about a subject, offer drill and

practice opportunities, or be designed to represent very realistic simulations and scenarios so that a learner can experience situations and phenomena without the actual investment of time, money, risk, travel, inconvenience, or self. Under the controlled conditions of a simulation, the learner may manipulate variables which allow experimentation never before experienced by learners except in real life. Figure 3 symbolizes the infinite patterns of lessons learners may draw from a well-designed lesson of this type.

Our challenge is to reorganize our approach, to begin making social and political changes which take advantage of these new technological systems. To fail to proceed with innovations of this type will insure that we will realize mostly negative effects of the technological revolution and perhaps forgo its benefits. It won't do to simply pour the old wine of earlier design approaches into the new bottles represented by these new delivery tools. We really do need to step out and experiment, to attempt to find unique and untried applications of the technology in an effort to improve both instruction and learning. Instruction in the humanities can take on a whole new dimension if we are able to rise to the challenge of this second implication.



MATRIX DESIGN

Figure 3

The third principle is fairly obvious. To accomplish any of the challenges put forth in the earlier discussion, designers of instructional systems must reorganize. New linkages must be formed which will provide adequate resources, technical inventiveness, and institutional adaptiveness.

Too long curriculum designers in the humanities have looked to the traditional sources, the Federal, state, or provincial government, for funds to finance their enterprises. As money from these sources has gradually diminished, developers have thrown up their hands in despair, closed down their enterprises, and gone into retirement until glimmers of new governmental funding are seen. Developing instruction and training using computers and videodisc will take capital. Designers must begin forming linkages with private enterprise, certification and regulatory agencies, investment capitalists, and private and public education agencies to acquire the capital needed so that adequate resources become available.

Technical inventiveness is really very widespread throughout the western world. Unfortunately, public-sector teachers and instructional developers often find themselves moving in circles not traveled by many of these inventive and creative people. Again, there is a need for developing new linkages with individuals from other disciplines, and attempting a dialogue with talented people outside one's normal domain.

Institutional adaptiveness may be the most difficult item within this last category. Old structures must yield to the pressure of the technology revolution. Administrative officers, though their own expertise often reflects experience in a pre-technology era, must begin to recognize trade-offs and advantages which need to be negotiated for the long-term benefit of the institution. Both within higher education and in large private corporations, those boards of individuals who make decisions are beginning to recognize the need for creating alternative structures which can quickly respond to market conditions, the changing needs of employees and user groups, and the demands of a technology-based society.

Dr. Alan Hofmeister, of Utah State University and Michael Rice, Senior Fellow of the Aspen Institute, have both been successful in forming interesting networks of talent which they bring to bear on important projects. Both manage to find resources outside the normal channels; they assemble teams of technical talent and inventiveness which appear on the surface superior to those commonly seen in typical university-based instructional design projects. Hofmeister recently managed to persuade the university to establish a quasi-private corporation, which will be located in a type of "research park," nominally attached to the university, from which his curriculum development efforts will be carried out. Joint funding of technology-based training programs has already been arranged with several large corporations. Although only time will tell whether the project will succeed, it has tapped new networks to obtain resources, technical inventiveness, and an adaptive response from the university.

Sometimes when an individual who has spent a lifetime studying and teaching within the humanities bumps into a technologist, sparks begin to fly. The technologist speaks of systematic approaches, cognitive maps, and machines. The humanist has an interest in art, history, and literature; human interaction is so vibrant, mechanization seems so cold and devoid of life. However, if a genuine attempt is made to communicate, usually both parties will recognize they have similar goals, but are focusing upon differing means.

Individuals who design instructional materials for the humanities recognize how few instructors there are who have the "gift." But by using the capability of a marvelous emerging new technology, we can create systems which typical teachers like you and me might use. Managing the best of these innovative new tools for instruction may result in remarkable improvements in the quality of what we present our students. A goal of any teacher is to have students engage in learning in an active enthusiastic way, to find success and feel actualized through the process, and to accomplish personal learning goals with efficiency. Early studies of the use of interactive videodisc instruction are showing positive trends which should cause us to pay attention. Perhaps the technology will accelerate achievement of this goal.

Bibliography

Bunderson, Victor C. "A Survey of Videodisc Projects at WICAT." *Performance and Instruction Journal* (November 1983).

DeBloois, Michael L. *Videodisc/Microcomputer Courseware Design.* Englewood Cliffs, NJ: Educational Technology Publications, 1982.

Hoekema, James. "Interactive Videodisc: A New Architecture." *Performance and Instruction Journal* (November 1983).

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Blueprint for a Comprehensive Foreign Language CAI Curriculum

James P. Pusack and Sue E. K. Otto

Academics who attempt to justify placing a word processor on every scholar's desk—and if possible, one at home, too—inevitably dwell on the beneficial impact these machines will have on scholarly productivity. Often the argument succeeds, for increased productivity means more research, more publication, more visibility for the institution. Can we apply this same reasoning to students, by invoking a concept of student productivity? While we have certainly tried, over the years, to give students the best possible conditions of learning, we have seldom endeavored to formulate a comprehensive plan, discipline by discipline, for the configuration of tools that would meet their needs. As long as the main tool in students' own hands was the book, one could hardly do more than provide bigger and better reading lists and libraries. Now that the microcomputer revolution has helped CAI to approach a point of maturity, or at least adolescence, it seems valuable to create a blueprint, a systematic sketch, of the means at our disposal for heightening students' productivity. Unlike books, computers actively respond to students' ways of learning; also unlike books, they consume resources and cry out for systematic planning.

One humanities discipline—the study of foreign languages—has demonstrated an extremely wide range of useful CAI applications. It is no longer necessary to downplay the possibilities lest teachers fear for their jobs. Most of us have grown comfortable with the late twentieth-century adage (origin unknown) that a language teacher who can be replaced by a computer should be. The now-familiar set of rationales for using computers in language teaching stretches from the potential for individualization to reducing didactic drudgery. Most discussions and project descriptions in the field, however, have focused on discrete, specialized tasks, without attempting a full and systematic vision of the possibilities.

In the blueprint projected here, we would like to postulate and describe an ideal pedagogical state based on technology available in the mid-1980s. We know that this state does *not* exist fully anywhere, on any campus, but we also know that the technology and expertise we possess today are fully adequate to accomplish what we describe. We will not imagine science-fiction worlds in which dandy androids speak and understand five million languages, nor will we invade research environments which require million-dollar student workstations. We will lay out the building blocks of a workable environment for productive language study.

A tragedy of modest proportions will emerge: a configuration of tools that could enormously heighten the learning productivity of foreign language students can be charted in detail here, but such a configuration will, in all likelihood, not be implemented in this century. We will not see it in place because it requires intensive, long-range planning and long-term effort on the part of faculty members, administrators, federal and private funding agencies, publishers, and manufacturers. In this sense, we view our blueprint as a provocation to all concerned.

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Dimensions

While many ways of categorizing the use of computers for teaching and learning have been proposed in the past, we have settled on four general classifications for our discussion: (1) *practice and diagnosis,* (2) *tutorial,* (3) *simulation and problem solving,* and (4) *utilities.*

Practice and diagnosis, as terms, need little explanation; although they are not usually viewed as a single category, they perform the complementary tasks of exercising a set of skills and measuring a student's mastery of those skills. Simple adjustments in the computer's help features and record-keeping functions can convert practice mechanisms into diagnostic procedures. The primary aim here is not to use the computer to teach concepts; it is assumed that the student has already been exposed to the basic information. Computerized practice provides the repetitive work through which the patterns of language are internalized. This electronic workbook supersedes its paper counterpart because it offers immediate feedback and, ideally, random selection of items and branching in response to student performance. Diagnosis or testing, like practice, provides feedback, though more prescriptively than descriptively. Because they rely on predictable forms of interaction, diagnosis and practice lend themselves to efficient management by machine. By employing the computer to deliver this kind of instruction, teachers can devote valuable class time to activities which can be meaningfully handled only by humans.

Tutorials combine the essentials of practice and diagnosis with the process of teaching concepts. Presentation of material on the computer requires a good program which diagnoses weaknesses or tests comprehension and progress through the instructional process in an individualized fashion. Failing to do this, many tutorials deservedly bear the dread epithet "electronic page-turner."

Simulation and Problem Solving. A computer simulation presents a model of an experience, makes the user a participant in a scenario of one kind or another. A simulation may take the form of a glorified tour which responds to choices made by the participant (e.g., a trip through a city or a museum) or may have a more challenging format in which the student must work with information or clues to reach a desired outcome. Simulations create a natural environment for language study in that the goal is appropriate use of language as the means to an end and not as an end in itself. The same holds true for problem-solving exercises, with the difference that the student attempts to solve a problem by using the resources of the computer, rather than actually playing a role controlled by the computer.

Utilities. In this category we include interactive computer facilities and systems which are not overtly or directly instructional, but which have the potential to improve the quality of teaching and the productivity of learning. These utilities include text editors, expert systems, database management systems, on-line dictionaries, and file manipulation programs. The capacity to access and display the same information in different forms for different purposes, to handle large quantities of information quickly and easily, and to carry out complex communication tasks on behalf of large groups of teachers and students—all this makes the computer a significant resource for language acquisition.

These four categories of instructional computing can be viewed as intersecting the goals of language teaching to form a kind of loose matrix whose cells may or may not be filled by actual applications (see Fig. 1). In the following discussion we systematically examine eight knowledge and skill areas in language study: grammar, vocabulary, pronunciation, conversation, listening, reading, composition, and culture. Like our categories of instructional computing, these areas overlap at every turn, so that no rigorous distinctions can be drawn. In particular, language teachers know that skill in one area can directly benefit skills in others.

These two dimensions interact with a number of others which can only be touched upon here: Does the student control the computer or the computer the student? Is the computer used for individual work, or does it stimulate group

interaction? Can instruction take place outside the presence of the instructor, or can the computer provide the basis for instructors to interact with one or more students? Do computerized materials function as independent instructional units, or are they closely integrated into work with a specific course and textbook? Each of these alternatives can contribute positively to a foreign language CAI curriculum. On the other hand, as we will see, certain language skills cannot and should not fall into the clutches of the machine. We endeavor to identify these aspects of language learning so that, as classroom teachers, we can concentrate our best efforts on them.

MATRIX OF LANGUAGE SKILLS

Grammar

Of all the areas of language study, grammar was recognized first as the most compatible with the computer. The structured elements of language found easy expression in the logically constructed world of computers. Moreover, there was and is great conviction in the argument for leaving mechanical activities to the machines, thereby freeing valuable class time for interactions handled well only by human teachers.

For the purposes of the conscious learning and application of the principles of grammar, students employ software that has become sufficiently sophisticated to handle even whole sentences in a pedagogically acceptable manner, the state of the art is such that traditional workbooks and written homework exercises are obsolete. Grammar topics are introduced by means of highly effective tutorials which rely on the lively elements of graphics and movement, combined with comprehension checking and individualized remediation. Through the use of computer-controllable audio tape decks, which also function as traditional recorders and players, students' grammar work encompasses both the spoken and written aspects of language. Drills that employ textual, audio, and video stimuli demand virtual mastery of forms and, along the route to this goal, provide helpful diagnosis of errors by analyzing students' individual responses and the cumulated patterns of their responses. Not only are wrong forms patiently corrected; the underlying sources of error—overgeneralization of paradigms, native language transfer, and the like—are hypothesized and targeted for special attention. In the transition from controlled drill to freely generated utterances, simulations and games provide a highly motivational setting and a logical context for using language.

The advantages of immediate, precise feedback for the student and the freedom gained by the teacher, who no longer must empty red pens onto endless student papers, constitute the perfect rebuttal to those who view computerized grammar practice as a boring or trivial application. As long as grammatical accuracy continues to be an essential measure of language proficiency, grammar practice will remain a staple of language learning. The computer can perform this task as well as or better than humans or non-interactive tapes or books.

Ultimately, the quest for proficiency demands systematic means of charting students' progress. A computerized item pool represents an invaluable utility for comprehensive language testing. Items stored with appropriate descriptive information are drawn off to generate multiple, parallel examinations, which can be used for diagnostic testing as well as for regular course examination. Two critical tasks—generating test items by linguistic rule and analyzing student's test answers with fully automated parsing programs—await significant advances in the linguistic capabilities of item pools and in the intelligence of natural language processing.

Vocabulary

Communicative ability in a foreign language increases in direct proportion to the size of the vocabulary acquired by the learner. Though not an isolated strand of language, vocabulary has too often been taught for its own sake in the language learning environment—relegated to lists of word equivalencies at the end of the chapter or to the backs of flashcards. With

advances in language pedagogy and technological support, such unimaginative means of building vocabulary have been partially supplanted by more interesting and challenging approaches. This is not to say that the flashcard technique has been abandoned, as a glance at textbooks and language software packages will quickly reveal. However, the increasing emphasis on the importance of communicative proficiency has fostered vocabulary building within a context, encouraging the student to focus on the combination of meaning and structure.

Of course, the computer handles flashcarding very well, certainly more precisely than a person working alone. Computerized practice of this sort represents an improvement because presentation can be endlessly randomized, missed elements can be reintroduced in the item sequence to encourage more complete mastery, and total accuracy is demanded of the learner.

The introduction of visual cues into teaching and drilling vocabulary with the computer transforms a mere translation exercise into learning that more appropriately focuses on meaning without the interference of the native language. Students acquire new vocabulary in context by responding to computer-controlled visuals, which include computer graphics, slides, and videotape or videodisc segments (both motion pictures and still frames). Well-executed graphics accurately evoke familiar objects that can be rendered in a stylized manner, but extensive use of computer-generated pictures invariably raises the issue of authenticity and in some cases clarity. What one artist draws on the screen as a potato may look more like a peanut to a student. With the use of photographic images, problems of realism disappear; videotape and videodisc offer the additional advantage of audio accompaniment.

An archive of still frames on a videodisc, combined with a database classifying the images, puts students in control of large amounts of high-frequency vocabulary. The same archive serves both self-contained CAI lessons and classroom presentations. The image database enables both students and teachers to find specific images or to select groups of images for more systematic study.

Many simulations and games also provide exposure to vocabulary and require correct use of vocabulary to succeed. In simulations, vocabulary usage is relatively incidental; it is a means to some end rather than an end in itself. While such vocabulary work is less intensive than in other types of CAI, the learner, often highly motivated to stay with the task, is experiencing vocabulary in meaningful, coherent situations and applying vocabulary with realistic results.

The most common type of vocabulary-oriented utility is the on-line dictionary. Students use this important resource while working on an exercise or a text, since recall and guessing will eventually fail. Although interactive dictionaries support explicit drill on vocabulary, their main function lies in their role as a help facility in computer-assisted reading, listening, rule-learning, and composition.

Pronunciation

In research and clinical settings computers have been producing and analyzing speech rather well for quite some time; computers have had considerable impact in improving the range and accuracy of speech studies. However, in the area of foreign language speech, that is, teaching pronunciation, we see very few applications. Two factors work against computer-based pronunciation activities. First, equipment which produces a reasonable result has been extremely expensive, while devices that are commonly available fail to meet the demands and standards of language learning. The affordable speech synthesizers on the market tend to produce intonation-free utterances that are recognizable to native speakers, but are unsuitable for teaching pronunciation. It makes more sense, at least for the near future, to use a tape recording or a real person as a model. Speech recognition units produce equally disappointing results, since they are unable to distinguish with sufficient accuracy amongst similar phonemes, and they require multiple utterances to formulate a model before work

begins. The second major drawback is that computerized pronunciation practice may well be overkill. A speaker with an obviously foreign accent can be granted a "superior" rating in speaking proficiency, according to one set of widely accepted proficiency guidelines. To exact computer-precise pronunciation from a student (particularly a beginner) is unnecessary and, even in more advanced stages of language acquisition, certainly not as important as having a broad enough vocabulary to avoid groping for words or good enough control of grammar to speak without errors that might interfere with understanding.

Despite these negative observations, there is a role for advanced speech technology in the realm of practice and diagnosis of pronunciation patterns. Currently, the computer-controlled acoustic analysis equipment that can analyze and compare utterances and produce graphic feedback is used primarily in areas such as speech and voice therapy and speech training for the deaf. It can be just as effective in teaching language learners. Beginning students with problems of discrimination or pronunciation, as well as advanced students who wish to fine-tune the quality of their speech, can benefit from computer-based lessons linked to such equipment.

Even without expensive acoustic devices, computer graphics can be used effectively to teach pronunciation skills by illustrating in animation the position and movements of lips, teeth, tongue, and throat in the articulation of sounds. The advantage of graphics is that they can provide transparent cross-sections, an impossibility with a live subject. Touch-screen recording of lip and tongue movements has also proved to be a popular drill activity.

Conversation

The mention of computerized conversation conjures up the specter of computers with speech synthesizers and voice recognition units addressing each other and responding, with no human intervention at all: the apotheosis of CAI in foreign languages. Meanwhile, the notion of meaningful free conversation between computers and people is comfortingly absurd. Language professionals will agree without exception that, given the state of the art of computer-based aural/oral skills, a much better methodology would be paying native speakers to converse with students in a convivial off-campus setting.

Although computers are not good at carrying on conversations, the use of computer-based or computer-controlled materials to stimulate or guide conversation should not be overlooked. In particular, computer simulations and video segments, which can be manipulated readily under computer control, make excellent conversational catalysts. Students describe their impressions, or predict the upcoming scene, or suggest appropriate dialog for a video sequence. Lively interaction also results when students work in a group with problem-solving programs or games; they spontaneously generate a great deal of discussion of strategies and possible solutions. The advantage of computer materials for stimulating conversation lies in the escape from linear, print-based sources of language. Computer-controlled environments offer unpredictable situations that make conversation natural, rather than artificial. Stimulation, not simulation, characterizes good CAI in conversation.

Listening

As international telecommunication and travel become increasingly important in our lives, the listening skill gains significance as a source of information. Printed matter, once the main font of knowledge about foreign cultures, now competes with radio and television to bring extended coverage of foreign realities into our homes. Foreign films arrive via cable television, international events receive in-depth coverage, and satellite broadcasts from abroad can be received at very little cost. Meanwhile, on the pedagogical front, the listening skill has been re-examined as a source of authentic language; it has come to be regarded as a highly active process consisting of numerous subskills that can be taught systematically.

The very same changes in technology that

have made it possible to import increasing quantities of video and audio materials into our classrooms have also revitalized the way students work with these materials. No longer must we assume that students will hover over tape decks, mesmerized and passive, as awkward dialogues roll onward. Cheap cassette players mean that every student works at home to acquire a familiarity with the sounds and expressions of the language. Authentic, high-quality audio and video recordings emanating from the "target" culture provide problem-solving experiences that are far more nourishing than the pablum we formerly accepted in our textbooks as feasts for students' ears.

The passive environment that inevitably characterized—some say condemned—the old-style language lab yields to highly interactive listening experiences via the medium of computer-controlled audio and video. Student audio/video/computer workstations, which have been likened to a language-learning cockpit environment, offer multiple forms of listening practice. At the lowest level, even grammar drill acquires a new dimension when simultaneous audio material under computer control contributes stimuli for typed student responses and aural reinforcement of correct usage. Two other audio media, digitized and synthesized speech, promise to add to our kit of tools for developing comprehension skills, but it seems likely that what they gain in flexibility they will lose in authenticity, in terms of both speech quality and faithfulness to reality.

The advent of computer-controlled video, in the form of videotape and videodisc, marks the start of a new era in listening and cultural comprehension; even hard-core euphoriaphobes may succumb to the excitement of this technology. The computer offers the student individualized control over images of foreign reality. Visual context combines with authentic language usage to provide an ideal learning situation. The contrast with group viewing of 16mm films could hardly be more striking. For American students, in particular, the opportunity to confront aspects of foreign cultures in controllable but authentic forms means that their limited exposure to the country itself, via travel and study abroad, begins at an optimal moment in their acquisition of the language. They experience, in advance, large amounts of the spoken language and the visual culture before their live immersion commences.

In addition to allowing the student to play and replay segments of language down to the individual sentence and word, the computer stands available as a complete listener's resource. Not only does it provide lexical aids and transcriptions; it also highlights cultural features, structures the development of specific listening skills, and provides comprehension checking as desired by either the student or the instructor. Videodisc-based simulations of real-life events lead students through myriad alternate paths, along which they hone their listening skills and interpret cultural cues by making decisions about the course of events. By adding the dimensions of control, context, and comprehensibility to aural work, computer-controlled audio and video guarantee students a listening skill that cannot fail them when they ultimately do immerse themselves in the foreign culture.

Reading

A dynamic, interactive, individualized teaching medi.br corresponds well to new concepts about the nature of the reading process and the role that reading plays in students' acquisition of a second language. Relegated until recently to a subordinate role in favor of the conversational skills, reading has been, like listening, gradually rehabilitated as a valuable source of authentic language usage. At the same time, improvements in computer equipment have transformed screen displays into much more powerful information-presenting instruments than the teletypes of the sixties and the glass teletypes of the seventies. We certainly do not want to commit reading matter to electronic memories in order to have students page through it hour after hour by pressing the RETURN key and answering follow-up multiple-choice questions. Reading programs must provide access to a wide variety of texts and allow students to de-

velop transferable text-controntation strategies.

At the elementary level the computer offers a transition from the native language reading skill to the corresponding skill in the target language. Beginning readers acquire both structures and lexical material from a wide range of authentic texts that conform to their personal interests. No longer are students restricted to a narrow corpus of texts printed in their "readers." By presenting relatively simple texts embedded in a context that fosters accurate guessing for meaning, the computer creates an exploratory environment that discourages word-for-word translation. Familiar texts, such as fairy tales; practical texts, such as menus and signs; and illustrated texts, such as instructions and cartoons—all these allow the student to stab at meanings and acquire comprehension naturally. Video material under computer control furnishes a rich context for students to refer to as they read dialogues, narratives, scripts of news broadcasts, and the like.

A critical role for the computer in this process comes at the moment when readers—both beginners and advanced students—attempt to identify personally stimulating reading tasks. From the selection of the text itself to the determination of the precise level of comprehension to be attempted, the student and the computer interact to design an individualized curriculum. Once the student has entered into a chosen text, the words and sentences become the surface level of a vast network of knowledge about the text itself and the language and culture that produced it. Students can choose simply to practice by reading and requesting subsequent comprehension checks; they can request tutorial assistance linked to any lexical, grammatical, syntactic, semantic, or cultural feature of the reading; they can request diagnostic evaluation of their reading skill and then be routed to appropriate remedial work before beginning the chosen text; or they can engage in a whole range of text manipulation and identification activities that build fundamental reading skills.

While practice and tutorial work prevail at the elementary level, intermediate and advanced readers engage in simulation and problem-solving activities. By playing roles in simulated real-world situations, readers put their developing skills to the test by learning to guess at meaning in a realistic context without recourse to a dictionary. Each text in the simulation becomes an adventure game and each adventure generates a different text depending on moment-by-moment decisions made by the reader. When the text is "re-read," it will be familiar, but different; complex simulations permit nearly infinite re-readings without inducing boredom. Other texts serve as the basis for problem-solving exercises. Students must make calculations, follow logical sequences of thought, deduce facts from subtle clues, query the computer for additional information, and eventually "solve" the text by reading it. In this kind of exercise, two problems must really be solved: the overt task, and the foreign-language text that contains the requisite information. In the interactive environment, students are not stymied by their linguistic failings; rather, they have controlled access to explanations, lexicons, structural paradigms, and supporting information. Tutoring in language rules and forms grows out of the interaction with the text and the desire to understand it.

Finally, at the most advanced level, the computer acts as a reference utility for the reader. As the tutoring function becomes less critical, the service function grows: the stored database helps the reader select appropriate texts and generates lists of unfamiliar vocabulary derived from previous reading experiences. If reading continues at the computer workstation, the texts are highly interactive subject-matter tutorials that serve to introduce the student to specialized vocabularies. Students majoring in natural sciences run simulations of physics or chemistry experiments to acquire the base vocabulary of their fields in context, without recourse to dictionaries. Literature majors execute textual analysis programs, for example, on Spanish texts and obtain a Spanish description of features of the text. Reading ultimately makes the transition from object of study to means of learning.

Composition

No dotted line marks the fuzzy boundary between grammar/vocabulary and the more integrative skill of composition. The term "writing" often encompasses all the work students do on paper. Here, we mean to distinguish the freer, more spontaneous forms of written expression from the regimented generation of utterances that often accompanies the learning of rules. As computers and their programs grow more intelligent, this distinction will become more and more blurred; practice with forms will take place under more open-ended conditions that strongly resemble composition. Creating language in multi-sentence and multi-paragraph chunks, however, requires a different set of computer tools than exercise with discrete syntactic units.

CAI in composition gives foreign language students a powerful arsenal of support mechanisms that insure higher-quality writing without the premature intervention of the instructor. The most universally useful of these mechanisms is the text-editing program, which serves both the writer and the translator. Stimulating students to revise their written work encourages the development of their self-critical skills; texts are never finished, always in progress. Composition teachers can afford to focus on expression and content in their first responses to students' writing, secure in the knowledge that as the text improves, the students' commitment to correct forms will only deepen.

Creation of text by computer also offers students and teachers the chance to capture writing at numerous stages in the transition from the first budding idea to the ultimate fruit of the compositional process. Prewriting exercises and "idea" processors aid students in the search for topic, audience, images, and structure. Style and spelling checkers aid in the analysis of strengths and weaknesses. Text comparison programs, by highlighting revisions, refine the revisions, refine the revision skill itself. Students collaborate with parsing programs to check for grammatical correctness.

Where the best efforts of artificial intelligence to understand human language eventually fail, the human teacher employs the computer less for analysis and more for communication. The output of programs that highlight revisions serves as the basis for human commentary. The limited "insights" of style checkers and parsers provoke discussion about advantages and disadvantages of specific structures. To a large degree the dialogue between writer and reader can itself take place at the computer, which becomes a communication center whose messages are embedded in the developing text itself. The instructor's comments and remarks on the student's writing, be they highly personalized reactions or stored generalizations, appear on the screen as windows superimposed upon the text; these windows give rise to student responses, so that layers of dialogue about writing gradually accumulate. Other students can also contribute their constructive comments about their peers' work in progress. Far from being the chaff of composition-teaching, the record of this dialogue is the grist itself. It defines the accomplishments of the student and feeds in-person writing conferences, which remain absolutely essential.

For the writing skill, then, the limitations of the computer become its strengths: the computer cannot understand the written text, but serves rather as a utility for the writer's own analytical tasks and as a communication center for the ongoing discussion of developing text. The computer helps both student and teacher to rise above the individual composition and to attempt an understanding of the student's actions as a writer.

Culture

In the field of foreign language teaching, "culture" functions as a code word meaning the totality of non-linguistic information about a foreign society. It encompasses everything from the response to a sneeze to the design of cathedrals. It is sublime and ridiculous, means and end, pervasive but ephemeral. While the teaching of culture should imbue the way every skill is taught, the daily focus on linguistic skills often forces teachers to address cultural topics

CAI Types: / SKILLS:	Practice Diagnosis	Tutorial	Simulation Problem-solving	Utility
VOCABULARY	?	?	?	?
GRAMMAR	?	?	?	?
PRONUNCIATION	?	?	?	?
CONVERSATION	?	?	?	?
LISTENING	?	?	?	?
READING	?	?	?	?
COMPOSITION	?	?	?	?
CULTURE	?	?	?	?

Fig. 1. Potential Matrix of Language Skills

CAI Types: / SKILLS:	Practice Diagnosis	Tutorial	Simulation Problem-solving	Utility
VOCABULARY	+	+	+	+
GRAMMAR	+	+	+	+
PRONUNCIATION	-->	-->	-	-
CONVERSATION	-	-	?	-
LISTENING	+	+	+	-->
READING	+	+	+	+
COMPOSITION	+	+	+	+
CULTURE	+	+	+	+

Legend: + feasible now
--> feasible soon
- not feasible
? questionable

Fig. 2. Completed Matrix of Language Skills

explicitly, in "capsules" and "modules."

To the extent cultural information can survive being codified as a sequence of facts, students can consume it at the computer in tutorial formats. In language study, students certainly need to absorb large amounts of basic data about foreign countries, yet work with factual knowledge during class can divert attention from active language usage. Imaginative tutorials, using graphics and sound, reinforce factual learning, while simulations of common situations spark subtle cultural insights at the same time they provide listening and reading practice. Nonverbal behavior submits to close scrutiny and analysis via computer-controlled video.

On the whole, great demands are placed on both the computer and the human instructor by teaching culture as more than a set of prepackaged facts and stereotypes. When they address the task too directly, teachers run the risk of trivializing a complex phenomenon. The live teacher's personal experiences abroad, expressed spontaneously in first-person narrative in the classroom, may contribute more to the transmission of cultural insights than any formalized lesson. The contribution of CAI to developing cultural insights in students lies primarily in the computer's ability to foster highly intensive interaction with authentic textual, audio, and video artifacts of foreign cultures. During such interaction, both implicitly and explicitly, the acquisition of cultural knowledge will occur.

Productivity Unbound

Releasing student productivity from classrooms and textbooks that chain individual learners to the pace and abilities of their fellows requires a truly Herculean effort. The matrix of ways the computer supports language study (see Fig. 2),

demonstrates strikingly that the computer fundamentally changes the nature of language learning and teaching. Giving students individualized control—skill by skill—over significant amounts of their work makes them highly productive learners.

A given student's weaker skills receive special attention; personal interests and subject-matter preferences influence the selection of listening and reading materials. The qualitative difference outweighs the quantitative: language-learning tasks become an active, intensive experience. The best students strive for real proficiency by exploiting a multiplicity of resources adapted to their changing ability levels.

Outside of class, students use computer-based systems for grammar rule-learning, vocabulary acquisition, listening and cultural comprehension (via video and audio), development of reading skills, and writing support. Away from the computer, they engage in less structured reading, listening, and writing. In class, the spoken language predominates as teachers work to foster oral proficiency, literary understanding, and intercultural awareness.

In the framework of this curriculum, teachers work in two directions. First, they endeavor to provide students with extensive opportunities for target-language conversation, both inside and outside the classroom. Second, they continuously create and renew the massive complex of computer-based materials that fill the language-teaching matrix. These concurrent efforts interlock to form a rich environment for language study.

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The Future of Teaching the Past: Computer-Assisted Instruction in History

Stanley W. Pycior

In its 1928 report to the Council of the League of Nations, the International Educational Cinematographic Institute announced that it had begun to study the potential educational applications of television. Although it was only four months since the Institute, which had been founded by the League's International Committee on Intellectual Cooperation, had opened its doors in Rome, its directors and staff had already begun deliberating several issues. Apparently most exciting to them was the educational use of television. The Institute had been created to encourage the production, distribution, and exchange among the various countries of educational films concerning instruction, art, agriculture, commerce, health, and social education. The Institute's report argued that television would make possible the distribution and exchange of such films in unprecedented ways. The international transmission of educational information over the airways would, by circumventing national taxes and tariffs on educational materials and bringing these materials into individual homes, foster international understanding. A television delivery system would make realizable the aims of the Institute, the International Committee, and even the League itself.[1] Fifty-six years later, even as we commend the Institute for its early recognition of television's potential, we must also lament the failure of its predictions.

Today, publications ranging from local newspapers to the newsletters of the leading professional associations sing the praises of computers as educational tools. On a cathode ray tube (which it borrows from one of its ancestors, the television), the personal computer will enhance education in the classroom and extend it into the home. Like television, the computer will democratize education by delivering the same high-quality educational information to all learners. Unlike television, which is not interactive, the computer will provide individualized, self-paced instruction. Each learner will be exposed to the material at an individualized rate and in a personal manner. Like other professional educators, historians have begun to herald the arrival of the computer as instructor. In a recent series of articles on computers and the historian in the newsletter of the American Historical Association, Michael M. Finerock considered the applications of computer-assisted instruction in history. He concluded that CAI "has the effect of distributing the fruits of technology, for while the benefit derived by really good students will probably be very great, with more and varied kinds of illustrations to show clearly what needs to be understood, the slow learners and nonverbal students who are usually disadvantaged in the regular classroom environment can be stimulated to catch up to their peers. . . . For those who have trouble interacting with others, the computer can offer an additional avenue to involvement."[2] Stephen P. Hueston, the developer of a sophisticated simulation of tenth-

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century Spanish society and politics, sees an even brighter future for computer-assisted historical simulations. By creating and using models for various periods in the twentieth century, politicians and diplomats would more clearly understand the forces which shape history and be able to predict the course of future events. Of this use of CAI, Mr. Hueston states: "I'd ultimately like to see the government use these predictions to get a better idea about how to handle foreign policy for the next 10 years. . . . Currently, there are economic models used by government planners. I'm trying to do the same thing with historical models."[3]

The purpose of this article is not to predict whether the computer will realize its educational potential as envisioned by Professor Finerock and Mr. Hueston or whether it will go the way of television as educator. Rather, it is intended to provide an overview of computer-assisted instruction in history and to afford a few recommendations on how the computer can avoid the fate of its educational ancestor, the television. To this end, the paper will describe the most common types of historical computer-assisted instructional materials, survey currently available CAI materials, and describe one project for the large-scale development of historical CAI lessons. An analysis of what has been done may shed light on what remains to be done.

I

The principal types of computer-assisted instructional materials currently available in history are drill routines and simulations. As in all academic disciplines, drill routines are the most available form of CAI. Perhaps because they are easily developed and because the computer has been identified with the delivery of "facts," computerized drills in various subjects have been available since the mid-1970s. The principle behind the creation of these routines is quite simple. Most teachers would agree that knowledge of certain facts and concepts constitutes minimal comprehension of a historical period. To insure that each student in a class has at least this level of comprehension, historians have developed review lessons which drill these facts and concepts. Like the programmed-learning books and the slide/tape machines which antedate it, the computer is utilized as a patient drill device. The computer has the additional advantage of keeping records on student performance and of prescribing academic remedies.

In the mid-seventies, historians at the University of Notre Dame developed fifty CAI lessons on the history of western civilization from the fall of Rome to the Cold War years. The development of these lessons and the results of the project will be analyzed later in this paper. For now, however, an example from one of these lessons will provide an illustration of computerized drill in history. A student who logged on to the computer system and called up a lesson was faced with a series of multiple-choice questions, with programmed responses for each. The questions were derived from the textbook; the responses frequently provided additional information not covered there. The lessons were intended not only to provide new information, but to drill the students on familiar material. A typical question follows:

> Like the Age of Reason, the Age of Romanticism affected every aspect of intellectual life—including philosophy, literature, art, religion, and politics. The concepts of the Romantic Movement varied from person to person and group to group, but the basic point of view common to all Romantics was
>
> 1. a belief that systematic inquiry could unlock the secrets of nature and human existence;
> 2. a belief that humankind's similarities were more important than its differences;
> 3. a new reliance upon emotion and imagination as sources of understanding;
> 4. a new reliance on the human ability to control one's own destiny.
>
> Your choice is?

Depending on the choice made, the student is looped to the appropriate response feedback:

1. This answer is incorrect. The opposite

was true. Romantics rejected the assumption that human reason functioning in a systematic way could analyze nature, explain human fate, or reveal the nature of truth, beauty, or justice. Romantics believed that knowledge of such phenomena came more from within than from without the individual. Intuition and inspiration were more certain pathways to that kind of knowledge than were those of reason.

2. This answer is incorrect. The opposite was true. Romantics valued what was unique and individual in people over what was uniform and general. Instead of explaining away ethnic and cultural diversity, they deliberately cultivated them as one of humankind's greatest wonders.

3. Your answer is correct. Romantics believed that people acted according to their inner natures. What they did depended upon the sentiments and passions they felt rather than on what their environment forced on them. The compulsion for self-realization was overpowering among the Romantics and frequently led them to defy law and convention and to trust their own insight and intuition rather than existing social standards.

4. This answer is incorrect. The opposite was true. Most of the heroes of Romantic literature were victims of circumstances which they could not control. Such characters struggled against fate and inevitably sacrificed themselves for great causes. No one could ever be sure about the future.[4]

A typical drill routine would consist of ten to fifteen of such questions with responses. At the end of the routine, the students would receive a score and a diagnosis of their performance. If the score were low, the diagnosis would be followed by a prescription, ranging from the suggestion to review certain sections of the textbook to the request that the student see the teacher.

Drill routines represent an early stage in the development of CAI materials. They do utilize the interactive and record-keeping abilities of the computer, but only at an elementary level. While the routines do present students with choices, they lead the students to certain preprogrammed answers. Drill routines frequently reduce the computer to an electronic page turner. In addition, almost all drill routines developed to date deliver only textual information and do not employ the computer's graphics capability. Because of these limitations, such routines have fallen into disfavor among CAI developers.

For those who actually teach history, however, drill routines are of quite practical value. As more high schools replace their survey course in American and world history with minicourses in recent history and with social science courses, college history teachers may no longer assume that every student has heard of John Quincy Adams or that every student knows that Adolf Hitler was not a communist.[5] In this context, computerized drill routines serve a remedial purpose. Use of the routines may be required of all students to guarantee exposure to the important facts and concepts, or they may be used on a referral basis to remedy the deficient background of certain students.

While educational theorists who design CAI materials and history teachers who use them can debate the merits of drill, both parties welcome the development of historical simulations. Employing the computer's vast memory, its sorting and computational powers, and its interactive nature, simulations replicate historical events and recreate whole eras. By placing users in a historical situation and by explaining all the variables which define the situation, simulations enable the user to work through the past and to make decisions which influence the course of events. As pointed out by Michael Finerock, "the possibilities are virtually endless. . . . Of course the topics for development as computer simulations include the rather obvious military conflict situations like the American Civil War; but also other events that involved an interplay of political, social and cultural variables such as the Congress of Vienna, the Scramble for Africa, the Norman Conquest, the General Strike, the Russian and the Puritan Revolutions, and any presidential election you would care to name."[6]

One of the most interesting and sophisticated

examples of historical simulations is a programmed model of tenth-century Spain recently developed by Stephen P. Hueston. As a history buff, he was dissatisfied with the monocausal, economic interpretation of history advocated by one of his teachers. This dissatisfaction, coupled with an interest in computers, resulted in a "sprawling, 6-hour historical program that traces the interplay of natural, political, economic, and religious factors that shaped Spain between the years A.D. 900 and A.D. 1080."[7] In order to re-create Spanish society and politics in the period, Mr. Hueston entered extensive amounts of data on each of the twenty-two Spanish provinces. For each one, six lines of data included information on political and religious status (Islamic or Christian), its ruler or ruling family, its wealth (number of churches, ships, and caravans), its military potential (number of infantry, cavalry, and warships, and its walled fortifications), and its agricultural production (acres of land in use, land available, and the percentage of land under cultivation). The model even quantifies the human characteristics of rulers: "Strength of character (the desire to manipulate an environment, in this case by controlling neighboring states) and strength of personality (the desire to see that what has been conquered is well managed) are also given numerical rankings."[8]

As with human characteristics, Mr. Hueston included judgments and processes into his model to insure a movement of events. For example, a province with great military resources was considered likely to attack its neighbors. To insure fidelity to history, the lifespan of certain rulers and the growth of certain populations was also specified. Mr. Hueston's goal, however, was not to mirror the past slavishly, but rather to simulate the interplay of factors which determine a situation. The outcome which results from a mixture of historical potentials and random variables, is unique to each run. Such models should help to identify and predict the forces shaping history.

This model of tenth-century Spain represents state-of-the-art simulation. It employs the information storage and retrieval powers of the computer, as well as its graphics capability, to replicate an era. It is, however, not for general use. Professional historians would question the merits of the model because its results may be at variance with historical fact. Few students would welcome the time and effort its use requires. As will be seen, simulations more like historical board games of the past are being developed for a more general audience. As in the case of Mr. Hueston's model, but without its rigor, these simulations will use the computer to recreate events and eras to provide an understanding of their determinants.

II

Although both computerized drill routines and simulations have been developed for over a decade, neither has been produced in great numbers nor found widespread use and acceptance. A search through the pages of *The History Teacher*, the leading journal on history instruction, leaves the impression that no one has developed computer-assisted instructional materials in history. In the last ten years, the journal, which is published quarterly, has contained numerous articles extolling the virtues of self-paced instruction and singing the praises of role playing, games, and simulations in the classroom. None of the articles, however, mention the possibility of employing computers in either capacity, although both self-paced instruction and simulation are clearly areas to which CAI would contribute. The only reference to educational applications of the computer comes in articles discussing the use of historical databases and statistical software in teaching historical analysis.[9] In "Can the Teaching of History Survive 1984?," a lengthy article in *The History Teacher* in 1977, four historians discuss the future of history instruction and offer recommendations for its survival past 1984. Although the authors recommend innovative teaching techniques and greater use of educational technology, they do not mention computer-assisted instruction.[10]

The picture painted, or rather the canvas left blank, by *The History Teacher*, is not, however, an entirely accurate representation of the state of CAI in history. Recently, articles have

appeared in historical and computer journals noting the development and availability of historical CAI materials.[11] In addition to the fifty tutorials developed at the University of Notre Dame in the mid-seventies, the following drill routines have been created: sixteen lessons in American History and sixteen in World history are available for the TRS-80 and Atari computers from Dorsett Educational Systems, seven 25-question quizzes on the United States constitution for use on Apple II systems are marketed by the Micro Lab Learning Center, and a series of lessons on ancient Egypt, Greece, and Rome and on the American presidents have been produced for the Commodore 64 in the Cymbal Computer Educator Series.

According to recent articles, simulations appear to be replacing drills as the most popular type of historical CAI materials being developed. Among the interesting simulations which have been created or are close to completion are: "Hail to the Chief," a simulation of a presidential election for use on the Apple II, from Creative Computing Software; "Shiloh," a recreation of a Civil War battle for the Apple II and the IBM PC from Queue Inc.; an interactive model of the British economy for the last twenty years, produced by Longmans; and a series of historical simulations of as yet unspecified length and content from Science Research Associates, a subsidiary of IBM. The search for these and other CAI materials in history and in other disciplines has been facilitated by the recent appearance of publications cataloging reviewing and educational software. These include: *LIST*, an apparently quarterly resourcebook describing software of all types for personal computers (Redgate Publishing Co.); *Academic Software*, a source book of educational software published by Software City; and *Swift's Educational Software Directory* from the Sterling Swift Publishing Company.

Not satisfied that the handful of CAI programs described in recent articles and listed in sourcebooks constituted an exhaustive list of available materials, I conducted a survey of over 500 colleges and universities to ascertain their use of and interest in CAI in history. The questionnaire, which was mailed to the history departments of all colleges in the United States with enrollments of over 1000 students, asked for a description of CAI materials in use or under development and whether the institution had plans to use CAI in history courses in the future. Of the 503 colleges contacted, 128 responded, with the following results:

Not using or planning CAI	92
Definite plans for CAI	3
Using statistical packages in classes	22
Using or developing CAI materials	11
TOTAL	128

The findings for the survey were indeed in keeping with the literature in the field. Few colleges are employing CAI materials in the teaching of history. A few responses even indicated hostility toward the idea of using computers to teach.

The largest number of positive responses to the survey came from historians using databases statistical software packages to teach students analytical skills. Such computer applications are not usually considered computer-assisted instruction, because they are not using the computer as a teaching machine; that is, statistical applications do not employ the interactive capability of the computer to deliver information directly to the student. The widespread use of such software, however, does illustrate the willingness of historians to employ computers in an instructional capacity, albeit in its established role as a research tool. Most of the twenty-two historians who employed the computer in this way indicated that their students were using SPSS, SAS, or another statistical package on a mainframe computer to analyze databases which the historians themselves had assembled. The exercises were intended to familiarize the students with the computer and with statistics.

Among those projects which exemplify the use of computerized statistical analysis in history classes are:

> At the University of Chicago, Dr. Keith Baker uses ARRAS (the Archive Retrieval and Analysis System) to analyze ARTFL (Amer-

ican and French Research on the Treasury of the French Language) databases (1600 texts including classic works of French fiction, nonfiction, and technical writing). In a course, "French Intellectual History," students use the concordance, dictionary, and distribution functions of the system to study literary themes and to trace concepts in literature.

At Holy Cross College, Dr. Theresa McBride uses SPSS programs to analyze the Comparative Cities database developed by R. Burr Litchfield and Howard Chudacoff of Brown University. In a course, "Man, Woman, and the Machine," students use SPSS to analyze the history of industrialization and family patterns.

At Mount Holyoke College, Dr. Robert M. Schwartz uses IDAP (a statistical package) to study an ICPSR (Interuniversity Consortium for Political and Social Research) database, "The Cost of Living of Textile Workers, 1888-1890." In a course, "Family, Community, and Class," students use IDAP to examine the lifestyle of textile workers and to discover their options.

At Swarthmore College, Dr. Marjorie Murphy introduces students to elementary statistical analysis of databases which they assemble. In a course, "Urban America," and the students code and analyze a Baltimore neighborhood; in another course, "Women and Industrialization," they code and study Massachusetts statistics on women mill operatives; and in another, "Work and Community," they code and analyze information on a township which includes several mill villages.

Instructors using these particular packages aim to acquaint students with the use of computers in research, to introduce them to elementary statistical analysis, and to familiarize them with historical methodology.

As mentioned above, eleven history departments indicated that their faculty had developed interactive CAI materials. Of the eleven, nine described their lessons as drill routines, one had created simulations, and one used both drill exercises and simulations. Their objectives were quite similar: to provide review routines for students, to insure that all students were exposed to the principal facts and concepts of the course, to identify and diagnose student problems, and to evaluate their own effectiveness in teaching. Although few of the materials have undergone formal evaluation, the findings of their developers have also been remarkably similar. CAI used increased test scores (on the "objective" and the essay sections of exams), students enjoyed using the materials and sought additional ones, academically stronger students benefited most from the use of the lessons, and costs were high and scheduling problems frequent when the lessons were run on mainframe computer systems.

The eleven CAI developers are:

Dr. Michael Carter, Dartmouth College, simulations in French History;
Dr. Robert E. Roeder, the University of Denver, programmed multiple-choice questions on two chapters of Palmer and Colton's *History of the Modern World*;
Dr. Samuel E. Fridie, Grambling State University, subject content drills and examinations for world civilization and American history courses;
Dr. Thomas J. Vavis, Howard University, multiple-choice drill and practice routines for American history and "primitive" simulations for economic history;
Dr. Ann Harrington, Mundelein College, review routines in basic historical concepts and definitions;
Dr. Robert E. Burns, the University of Notre Dame, fifty tutorials covering the history of western civilization;
Dr. Michael G. Hall, the University of Texas at Austin, drill and practice routines for a United States history survey course;
Col. Carl W. Redell, the United States Air Force Academy, drill and practice lessons for a western heritage course;
Col. Roy K. Flint, the United States Military Academy, multiple-choice review exercises to reinforce factual information, for use in the Military History Division;
Cmdr. James W. Williams, the United States Naval Academy, 106 ten-question computer-

assisted study quizzes for two courses, "Western Cultural Heritage to 1815" and "Civilization and the Atlantic Community Since 1776"; Dr. Donald Dietrich, the University of Wisconsin at Stevens Point, ten-question multiple-choice quizzes with diagnostic features for use in an American history survey course.

These CAI lessons vary in length, coverage, and sophistication. They are also written in several different computer languages and are supported by a variety of computer systems. Surveying the field of available historical CAI materials suggests that diversity rather than uniformity is the rule. Since uniformity, and the resulting transportability of software, are essential for the general acceptance and use of such software, a principal concern of future developers of CAI materials must be insuring uniformity and compatibility. This concern will be addressed in the last section of this paper.

III

The development of CAI tutorials at the University of Notre Dame for courses on the history of western civilization illustrates the process of developing such materials, their effectiveness in the classroom, and the issues raised by their development.[12] In July 1973 a group at Notre Dame received a grant from the Alfred P. Sloan Foundation to develop computer-assisted tutorials and videotaped lectures for introductory economics courses and a two-semester course in the history of western civilization. At the time, computer-assisted instruction was first being explored as a medium for programmed learning, essentially as a drill device. The developers at Notre Dame intended to employ the drill function of CAI but to expand its information delivery function. Their objective was to write fifty tutorials, consisting of approximately twelve questions each. These were to be compatible with any college textbook and to be in a popular computer language to insure their adoption at other universities.

The results of the project resembled fairly closely the objectives of the authors. For fifty-two lessons covering the period from the third century A.D. to the end of World War II, 579 questions were written and presented in a four-option multiple-choice format with lengthy programmed responses for each choice. Overall, the amount of written materials in the fifty-two lessons exceeded 2200 double-spaced typed pages. The questions and responses were categorized into three types: basic events review, information delivery, and analysis of abstract concepts. Questions categorized as "basic events review" deal with historical subject matter and/or statistical data sufficiently important for use in any western civilization course. Questions styled "information delivery," involving special emphasis rather than consensus, relate to subject matter not necessarily found in all the leading texts, but emphasized by a particular professor or text. Questions described as "analysis of abstract concepts" are concerned with concepts such as feudalism, mercantilism, romanticism, and imperialism. These questions are usually employed in a sequence, first supplying the definition of a concept and then asking the student to apply it. Although essentially drill routines, the Notre Dame tutorials deliver, in their programmed responses, information not contained in assigned readings and require students to extrapolate from information contained in the readings.

The lessons were used for the first time in a freshman western civilization course in 1975. Of the approximately fifty students in the course, twenty-five were instructed in the conventional manner: they met with the professor two hours per week and with a graduate assistant for an additional hour-long discussion. The remaining twenty-five students likewise met with the teacher and the graduate assistant, but they also ran two tutorials per week. On the first examination, their average grade was 86 and that of the control group was 76. This experimental group scored better on both the objective questions and the essay questions.

As a result of this first exam, the experiment immediately broke down. Students in the control group began to use the tutorials surreptitiously. In fairness to the students, all were given access to the CAI lessons. On the next

major test, what had been the control group outscored the experimental group 88 to 86. Not only did grades improve, but an informal survey of student reaction to the tutorials yielded the following results: 98% believed the CAI materials improved test scores, 83% indicated willingness to enroll in other courses employing CAI, and 78% believed they learned more from the CAI exercises than from the discussion leader. While 69% of the students indicated that the use of such tutorials should be optional, only 15% wanted to abolish them and only 9% found them impersonal and dehumanizing. In general, aside from discontent over system breakdowns and the unavailability of terminals, student satisfaction was quite high.

Staff reaction was not nearly as favorable. In the development stage, the project director quickly learned that a firm editorial hand was needed. The lessons authored by faculty were historically sophisticated, but revealed little concern for their intended audience, freshmen, and almost no concern for the compatibility of the lessons with the leading texts. When written by the graduate fellows involved in the project, the lessons were more general in content, more tailored to their audience, and compatible with the six major textbooks.

In the implementation stage, faculty dissatisfaction grew. In the course which first used the lessons, the instructor described it as "one of the most trying and exasperating classes he had ever taught."[13] Although not involved in the planning and development of the lessons, he had been chosen for his teaching prowess. He entered the course viewing the lessons solely as review routines, useful supplements to lectures and readings. Neither he nor the project developers had anticipated the tremendous information-delivery capability of the tutorials. Because of their length and because of the time students spent using them, the tutorials provided more information than the teacher. Some students felt that the teacher was drifting from the heart of the course, the CAI tutorials. The lessons had simply displaced the instructor as the central element. This situation resulted from the failure to integrate the tutorials and the lectures. Instead of meeting their principal objective of freeing the teacher from the concerns of coverage, they displaced him. While this situation presented problems that had to be faced and solved, it did reveal the great educational potential of CAI materials.

Two other problems encountered by the Notre Dame developers were the incorrect choice of programming language and the disinterest of history faculty not involved in the project. As in many early CAI endeavors, the Notre Dame authors looked to the university's computer center for advice on a selection of the language in which all the lessons would be programmed. The requirement of the authors was simple: the lessons must be transportable, for the grant proposal stipulated that the materials produced would be disseminated. The advice of the data processing staff was equally simple: PL/1, for it was to be the language which most systems would soon be using. All the tutorials were therefore written in PL/1, but within two years, to make them actually transportable, they were rewritten into BASIC and FORTRAN.

The problem of faculty apathy and disinterest was not as easily solved. Although several members of the department reviewed the materials, none chose to use them in their classes. Their reasons varied: the lessons had not been sufficiently tested, students had problems getting into the system, and teachers shouldn't spoon-feed students. In fact, however, most faculty members were preoccupied with their own teaching and research. Even the most sympathetic instructors were unwilling to invest the time and effort required to design and write tutorials or even to redesign their courses to use existing ones. The junior faculty members, facing the "publish-or-perish" threat, were presented with a dilemma. They were interested in the lessons, but had no incentive to adopt them. These two issues, computer language compatibility and faculty incentive, will be addressed in the final section of this article.

IV

A review of the literature on computer-assisted instruction reveals that these materials can

improve test scores, provide individualized, self-paced instruction for fast and slow learners, and liberate teachers from the more monotonous routines of instruction. With the advent of the personal computer, the costs of computing, including running CAI materials, have been substantially reduced. Because of its educational efficacy and its new affordability, computer-assisted instruction will play an increasing role in education, including history teaching.

The ground has already been broken in historical CAI. Commercial software companies and computer manufacturers are developing and marketing drill routines for home computers, particularly for Atari, Commodore, and Apple systems. At best, this software is of uneven quality and is aimed at the home and secondary-school market. CAI materials developed at various universities, while they might be more historically sophisticated and challenging, are of limited use since most of them were not designed in the context of marketing considerations, such as compatibility and transportability.

If historians are to take the lead in developing and disseminating a second generation of high-quality CAI materials, standardization and systematization are needed. Individual teachers cannot be expected to write their textbooks, nor should they be called upon to produce their own CAI lessons. To insure the development of availability of high-quality transportable CAI software, the following recommendations seem in order.

1. The leading professional organizations, including the American Historical Association and the Organization of American Historians, must take the lead in establishing guidelines for developing CAI materials. Both associations have recently undertaken efforts to disseminate information on the production and availability of such materials. The O.A.H. has sponsored a survey of CAI lessons. Within the A.H.A., an even more dramatic development has been the recent creation of a CAI special interest group with the announced purposes of publishing a CAI newsletter and organizing conference sessions on the applications of computers in teaching history. Either this interest group or the teaching division of the organizations must begin the work of establishing guidelines for the production of CAI materials, particularly in such areas as the choice of programming languages (BASIC and PASCAL appear to be possible choices), software transportability (IBM compatibility may be necessary within a few years), and the format and subject areas of possible materials (existing drill routines in American history and the history of western civilization may already be adequate, while simulations in all areas are needed).
2. Foundations, federal agencies, and publishers should fund large-scale projects for the development of CAI materials by professional historians. Their funding, however, should be contingent upon the developers' adherence to the guidelines specified by the professional organizations. When the National Endowment for the Humanities sponsored a meeting last year to establish guidelines for reviewing proposals for CAI projects, the transportability of software was one of its primary concerns. The experience of CAI developers has shown the need for outside funding. In return for this funding, the agencies may specify standardization.
3. A consortium of historians interested in CAI, such as the special interest group mentioned above, should publish a newsletter or journal on historical CAI. The publication would advertise, catalog, and evaluate historical CAI materials. The effort to unite interested parties in this way has been made, but further coordination is needed.
4. In order to motivate professional historians to create CAI materials, the development of CAI lessons and other software must be factored into decisions concerning tenure and promotion (the respondents to my survey indicated that it had not been). In some of the social sciences, the production of software, which is marketed and adopted at other universities, is already recognized as

a type of publication. The professional organizations should address this issue, in establishing guidelines for CAI development.

The effectiveness of CAI has been demonstrated; the work of standardization and dissemination remains. This work may be performed by professional historians or by commercial software developers. Historians should learn from the experience of the International Educational Cinematographic Institute. As early as 1928, the Institute foresaw the educational potential of television. It was, however, commercial developers and not educators who ultimately controlled the production of materials for television, with results we lament today.

NOTES

1. *Documents of the Council of the League of Nations*, C.591.1928.XIIA, pp. 5-6.
2. Michael M. Finerock, "Computers and the Historian, Part III: Overcoming Computerphobia in Office and Classroom," *American Historical Association Perspectives*, 22:1 (January 1984), 12.
3. Stephen P. Hueston and Alan Joch, "Spain on a Disk: Reliving History with the PC," *PC Magazine*, 2:7 (December 1983), 331.
4. "Nineteenth-Century Intellectual Trends," *University of Notre Dame Tutorials in Western Civilization*, Tutorial 41, Question 1.
5. In a recent conversation, I was surprised to hear a junior in college say that Hitler was a communist. I learned that history was not required at her college and that, in her high school, history had been integrated into a general social studies course.
6. Finerock, p.11.
7. Hueston, p.318.
8. Ibid., p.318.
9. For examples of this application see Orville Vernon Burton, "Using the Computer and Manuscript Census Returns to Teach American Social History," *The History Teacher*, 131:1 (November 1979), 71-88; and James P. Whittenburg, "The Computer as a Teaching Aid: A Report on Two Class Projects," *The History Teacher*, 9:3 (May 1976), 433-442.
10. Hugh B. Hammett, Charles F. Sidman, Thomas Longin, and Henry P. French, Jr., "Can the Teaching of History Survive 1984?" *The History Teacher*, 10:2 (February 1977), 229-248.
11. For details on the available CAI materials mentioned in this section, refer to Lawrence H. Douglas, "Software and the Historian: A Revolution Yet to Come," *OAH Newsletter*, November 1983, p. 23; Michael Finerock, op. cit., pp.11-12; Richard Jensen, "The Microcomputer Revolution for Historians," *The Journal of Interdisciplinary History*, 141:1 (Summer 1983), 106-7; and Don Karl Rowney, "The Historian and the Microcomputer," *Byte*, 7:7 (July 1983), 170.
12. For a detailed description of the project see Robert E. Burns and Stanley W. Pycior, "Computer Managed Tutorials in History," *Proceedings of the 4th Annual Conference on Instructional Computing Applications*, Indiana University Computing Network, March 1977, pp.21-29.
13. Ibid., p.23.

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Computers Come of Age in Writing Instruction

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For those who write, teach writing, or assign term papers, new concepts in computer assistance for writers promise fundamental change. Six years ago, Lorinda Cherry, a computer scientist at Bell Laboratories in Murray Hill, New Jersey, created several programs to analyze English texts for weaknesses in diction and style.[1] Building on her work, members of the Documentation Technologies Group at Bell Laboratories in Piscataway, New Jersey, added dozens of complementary programs, creating a series now known as the UNIX* WRITER'S WORKBENCH Software.[2] At other institutions as well, similar efforts were under way. In 1981 Michael Cohen at UCLA produced the much publicized HOMER program.[3] Ruth Von Blum, also at UCLA, and Michael Cohen have now developed WANDAH, the first comprehensive package covering the writing process from beginning to end.[4] Research at IBM, similarly, includes work on EPISTLE,[5] a series that suggests the potential of grammatical analysis with computers. During this same period, other forms of computer assistance for writers have also begun to appear, the most promising being interactive process programs.[6] Quite unlike the programmed texts and canned exercises of old, these new programs focus attention on the writer's own work and offer aids for more rapid and successful writing.

More important for the teacher and the student of composition, however, these new programs promise to become an essential part of composition training. Since 1982 at Colorado State University, for example, thousands of students in hundreds of composition classes have used computers for assistance with writing problems. The CSU Center for Computer-Assisted Writing began in 1981 when Charles Smith and Kate Kiefer, with support from Thomas McCall at the CSU Computer Center, began a project to develop and to test programs for textual analysis.[7] Learning of similar but much more extensive work at Bell Laboratories, CSU negotiated a research exchange with Bell permitting CSU (in support of Bell Laboratories' program for in-house testing) to adapt and to test the WRITER'S WORKBENCH software for teaching composition. As a result, 170 students in the composition program at CSU tested these computer programs during the 1981-82 school year. In the fall of 1982-83, 1250 students began using the WORKBENCH to analyze all their written work for help with spelling, mechanics,

*UNIX is a trademark of Bell Laboratories.

Patricia S. Gingrich, now a member of the Technical Staff, UNIX Systems Engineering, AT&T Bell Laboratories, Summit NJ, was a member of the Documentation Technologies Group at Piscataway NJ, and liaison between the Laboratories and the CSU Project in 1981-82.

Kathleen E. Kiefer, an associate professor of English at Colorado State University, is Director of Basic Writing at CSU, co-head of the CSU Project for Computer-Assisted Writing, author of Making Writing Work: Effective Paragraphs *and* Thinking, Reading, Writing, *and co-editor of* Computers and Composition, *a newsletter.*

Charles R. Smith, an associate professor of English at Colorado State University, is co-head of the CSU Project for Computer-Assisted Writing.

diction, organization, and style. In the spring of 1983, the number of students using the WORKBENCH rose to 1600. Now (fall, 1984), over 2300 students use the WORKBENCH and other software for writers.

Our experience with hardware, with software—in particular the UNIX WRITER'S WORKBENCH Software—and with costs of computer assistance suggests that all who write, teachers and students especially, will want these new tools.

Hardware

Until recently, required maintenance by trained technicians, special environments, and high initial cost made computers too expensive for writing programs. But with the recent development of low-end minicomputers and powerful micros, even multi-user systems large enough for the UNIX operating system are now well within range of most academic budgets.

WRITER'S WORKBENCH, the most important software in the CSU arsenal, runs on five small minicomputers, each about the size of a small suitcase and requiring no special air conditioning. Each of these computers is connected to five or seven CRT (cathode-ray tube) terminals and a letter- or other high-quality printer. All the hardware operates in a large classroom conveniently housed in the English Department, not in the University Computer Center. Composition students arrange to spend an hour a week or two hours every other week (depending on writing assignments and teaching syllabus) in the terminal room.

Because the terminals have rows of clearly labeled special-function keys just above their typewriter keyboards, students can begin at once to set margins, reformat text, underline words, delete characters, open spaces, and so on. Simple to use, these terminals permit students—even nontypists—to enter and edit their first writing assignments after just an hour's self-instruction. The printers, of course, can prepare perfectly typed essays without correction tape, white-out, erasures, or typographical errors. Undergraduate monitors handle computer problems as a matter of routine and take care of all regular maintenance from cleaning heads in the tape drives to backing up the five systems. Because of such developments, computers can easily become tools in English departments, just as they once were in university computer centers.

Software

Important as developments in hardware have been, computers are becoming indispensable adjuncts to composition classes because of developments in software. A series like the UNIX WRITER'S WORKBENCH Software provides a good example of current trends that soon will offer a multitude of varied programs for computer assistance in composition. The WRITER'S WORKBENCH system consists of more than thirty programs of four types. The most useful for composition training and the most original are the programs that analyze text. Some of these programs assist with editing (spelling, punctuation, diction, and grammar); others analyze more broadly (organization, content, and style). The STYLE program, for example, is particularly powerful inasmuch as it analyzes text for variety in sentence length, structure, and openings; excessive reliance on passive voice, nominalizations, and *to be* verbs; readability score, excessive numbers of long words, and so on. A second group of six programs gives supplementary information: a glossary of usage, certain rules of punctuation, and the like. Cross references throughout the WORKBENCH enable users to make full use of these informational programs. A third and more basic group consists of three programs for "environmental tailoring," that is, assisting users to add to or to change existing programs. A user may thus add new words to the list flagged by the diction program or the spelling program. Among the most important programs in this group is MKSTAND, a program permitting users to develop stylistic standards based on, say, a series of the best papers written for beginning composition or the best articles appearing in *College English* or *Chemical Engineer*. The resulting standards can then be used as stylistic models, as targets, for similar

```
                    Programs For Textual Analysis

abstract . . . . . evaluates text abstractness
acronym  . . . . . finds acronyms
chunk  . . . . . . segments text at phrase boundaries
findbe . . . . . . indentifies to be verbs
match  . . . . . . collates statistics from different texts
organization . . . prints first and last sentence of paragraphs
sexist . . . . . . finds sexist phrases and suggests changes
spelltell  . . . . gives full spellings from correct parts
style  . . . . . . summarizes stylistic features
syllable . . . . . prints words of n syllables or longer
topic  . . . . . . enumerates repeated content words
  parts  . . . . . assigns parts of speech
wwb  . . . . . . . runs proofreading programs and stylistic analysis
  proofr . . . . . runs proofreading programs
    dictplus . . . finds awkward phrases and suggests changes
      diction  . . finds awkward phrases
      suggest  . . suggests substitutions for awkward phrases
    double . . . . detects contiguous appearances of the same word
    punctuation  . checks punctuation
    spellwwb . . . checks spelling using spelldict
    grammar  . . . finds split infinitives and misuses of a and an
      parts  . . . assigns parts of speech
  prose  . . . . . gives extended editorial comments
    style  . . . . summarizes stylistic features
      parts  . . . assigns parts of speech

                        Explanatory Programs

punctrules . . . . explains certain rules of punctuation
gramrules  . . . . explains certain rules of grammar
worduse  . . . . . contains a glossary of words often confused
wwbhelp  . . . . . gets information about a word
wwbinfo  . . . . . contains a list of all Writer's Workbench programs
prosestand . . . . prints standards used to evaluate documents

                    Programs for Environmental Tailoring

dictadd  . . . . . adds phrases to the diction dictionary
spelladd . . . . . adds words to the spell dictionary
mkstand  . . . . . creates standards from model texts

                        Personal Programs

ddict  . . . . . . personal list of awkward phrases
sexdict  . . . . . personal list of sexist phrases
spelldict  . . . . personal list of spellings
```

Figure 1. WRITER'S WORKBENCH Programs

texts. Finally, the WORKBENCH contains three dictionary files that can be created by users to adapt the system's spelling or diction dictionaries. The WRITER'S WORKBENCH programs thus offer helpful advice when the writer most needs it—at the keyboard itself. Figure 1 is a list of the individual programs.

WRITER'S WORKBENCH in the Writing Class

As originally designed, the WRITER'S WORKBENCH programs were intended for Bell System writers; using them in freshman composition therefore required changes. While the programs for environmental tailoring assisted with some of these changes, one in particular required a computer programmer.[8] As originally designed, the WORKBENCH programs assumed that users would have continuous access to terminals, would run the programs, and then make corrections and revisions at the terminal. Thoughtful correction and revision on-line, however, require significant terminal time. CSU thus created a

program stringing together appropriate WORKBENCH programs so that students, after entering their essays, might take away output for analysis and revision. Faculty prepared a glossary and user's manual[9] to help them interpret the output and to replace the on-line informational programs, WORDUSE, PUNCTRULES, and SPLITRULES. As a result, students come to the terminal room, and in one hour type in last drafts of their essays, run the spelling checker, give one command, and receive copies of their essays with six or eight pages of output from the programs.

After analyzing the output, making revisions and corrections as necessary, most students return for a half hour or an hour later in the week to make final copy. They call up the computer record of the original, make corrections, give one command, and receive automatically typed, letter-quality essays to hand in for grading. After the professor has marked an essay, a student may revise again simply by calling up the original essay, revising, rechecking, and resubmitting.

To gain some idea of the value of current software for writing laboratories, consider the output students take home from the Center before preparing final copy of their papers:

1) ORGANIZATION, the first program to appear on the output, prints the first and last sentence of each paragraph. Teachers who encourage students to write formal paragraphs have found this simple program valuable for strengthening the essay as a whole. In a formal essay, typically, the first sentence of each paragraph (often the topic sentence) introduces the idea of the paragraph and offers a smooth transition from the preceding paragraph; the last sentence clinches or emphasizes the main idea. A teacher finding serious weaknesses on this page can simply require revision before marking the essay. This program, of course, is of little value for informal and journalistic prose, but for students learning to write formal essays, it illuminates weaknesses in organization and coherence and encourages students to revise again before handing essays in.

2. DEVELOPMENT,[10] a program developed at CSU, follows ORGANIZATION. It counts the

```
                                DICTION

Sentences with possible wordy or misused phrases are listed next,
followed by suggested revisions.


For file pas-20

The war, as *[the author]* calls it, in America is a *[very]*
serious problem *[which]* can and must be brought to an end
through positive and forceful actions by the nation's people and
government.

beginning line 3 pas-20
The essay addresses a *[very]* serious problem, but the suggested
methods of correction are not altogether correct.

beginning line 9 pas-20
However, Americans must *[make a]* choice whether to protect
their lives and loved ones or to protect rights such as those
*[which]* prevent police from searching suspected people and
their property.

beginning line 18 pas-20
The causes of crime listed in the essay are *[basically]* sound,
but the solution presented is ludicrous.
```

Figure 2. Sample Results from DICTION

words in each paragraph, calling students' attention to any paragraph significantly shorter than the average for strong essays in composition. To be sure, the accompanying text points out that paragraphs may vary from one word to many sentences, but it notes that a typical weakness of paragraphs is a lack of development. The program then specifies which paragraphs should be examined and includes specific comments when short paragraphs include the introduction or conclusion.

3) FINDBE capitalizes and underlines all forms of *to be* in the draft copy of the essay. This program thus calls attention to a common weakness, reliance on the most overused verb in the language. *To be* verbs are, of course, often necessary, but avoiding excess adds life and interest to the subject and variety to sentence structures. Avoiding *to be* verbs also eliminates expletives (*it is, there is, there are*), other fillers (*which is, which are, this is*), and, of course, passive voice. This program effectively sensitizes students to the importance of choosing verbs wisely and offers the teacher, at a glance, important information about the student's essay.

4) DICTION (Figure 2), one of the most powerful and most useful of the WRITER'S WORKBENCH programs, flags about 500 words and phrases potentially wordy, overused, unspecific, "incorrect," inflated, or sexist. In the CSU version, potential weaknesses are now flagged with asterisks and brackets in the FINDBE version of the essay. This program can be modified to flag any word or phrase a teacher might wish to mark—every "very," every "due to the fact that," every "hassle"—and, if the action is appropriate, the student can remove or change the phrase before the teacher marks the essay. Because the computer does not analyze context, DICTION calls students' attention to potential problems only, not always to real ones. Students must therefore continue to think critically. As comments and questions in class show, a valuable side effect of using this program is that students are becoming more sensitive to language itself, not only to words and phrases better omitted or changed.

5) SUGGEST (Figure 3), following the draft version of the essay, provides advisory comments and suggests replacements for flaws in DICTION. In Figure 2, for example, DICTION flags "the author" and SUGGEST (Figure 3) notes that using "I," "we," or "author's last name" is usually better; in Figure 2, DICTION flags "which" and SUGGEST (Figure 3) refers the student to the "Glossary" (a paper adaptation and expansion of Bell's on-line WORDUSE program) for instructions.

6) VAGUENESS complements DICTION by alerting students to excessive numbers of vague and general words. This program relies on a dictionary of about 140 words, e.g., *most, many, several, interesting, fun.* When the vagueness index reaches five percent, the program prints a list of all vague or general words in the essay and offers advice about revision. This program, a CSU extension of the WORKBENCH, relies on the structure of ABSTRACT (below).

7) SPELL helps students catch most misspelled words and typographical errors by comparing every word in a text with a computerized dictionary. Because the spelling checker does

```
                                SUGGEST

basically:  use "OMIT" for "basically [OVERUSED]"
make a:  use "GLOSSARY" for "make a(n)"
the author:  use "I, we, OR LAST NAME OF AUTHOR" for "the author(s)"
very:  use "OMIT" for "very [OVERUSED, INSPECIFIC]
which:  use "GLOSSARY" for "which"

   *Not all revisions will be appropriate for your paper.
    When several suggestions appear for one bracketed word,
       choose appropriately.
```

Figure 3. Results from SUGGEST

not contain all words, some items in the list of possible misspellings are correct, as are many proper nouns. This "deficiency," of course, is an advantage for the composition teacher because it encourages skepticism about spelling: the computer helps students question themselves, and students, in turn, must question the computer. Also, the computer cannot distinguish between homophones (*principle, principal*), it will not flag a word like *skyline* spelled as two words because both *sky* and *line* are correctly spelled, and it occasionally misses a word incorrectly spelled because it strips away some suffixes and prefixes before checking for accuracy. Despite its limitations, the list of potential errors SPELL offers is so complete that students regularly eliminate every misspelled word in their essays. SPELL runs twice on each essay, first when students run it at the terminal to remove obvious typographical and spelling errors and again when they receive output from other programs so that they may check the list against a dictionary. As every composition teacher can guess, the SPELL program eliminates a good deal of marking and saves students—especially weak spellers—much agony.

8) PUNCTUATION, elementary at its present stage, offers good advice on several important points: missing quotation marks or parentheses, missing capitals following periods, commas and periods outside quotation marks, and so on. CSU is now testing additions to this program.

9) DOUBLE is an editing program that flags contiguous appearances of the same word, an occurrence more frequent with text editors than with typewriters.

10) CHECK, a CSU program, uses the DICTION structure to caution students when they are using a word or words frequently confused with another: *affect, effect; passed, past; populace, populous.* Short definitions or references to the glossary encourage students to check for possible error.

11) GRAMMAR, program still at a developmental stage, flags most split infinitives and catches misuses of *a* and *an*. CSU is also testing additions designed to flag fragments.

12) STYLE (Figure 4), found by composition teachers to be one of the most useful WORKBENCH programs, offers a variety of statistical information to help students with style. This

STYLE

```
readability grades:
  (Kincaid) 12.7  (auto) 12.9  (Coleman-Liau) 12.8  (Flesch) 14.5 (40)
sentence information:
  no. sent 37  no. wds 759
  av sent leng 20.5  av word leng 5.11
  no. questions 1  no. imperatives 1
  no. content wds 456  60.1%  av leng 6.66
  short sent (<16) 22% (8)  long sent (>31) 8% (3)
  longest sent 40 wds at sent 4; shortest sent 5 wds at sent 29
sentence types:
  simple 49% (18)  complex 35% (13)
  compound 8% (3)  compound-complex 8% (3)
word use:
  verb types as % of total verbs
  to be 28% (21)  aux 16% (12)  inf 20% (15)
  passives as % of non-inf verbs 8% (5)
  types as % of total
  prep 12.3% (93)  conj 2.9% (22)  adv 4.2% (32)
  noun 27.8% (211)  adj 20.2% (153)  pron 3.6% (27)
  nominalizations  3% (22)
sentence beginnings:
  subject opener:  noun (5) pron (5) pos (1) adj (4) art (7)  tot  59%
  prep 8% (3)  adv 19% (7)
  verb 5% (2)  sub-conj 8% (3)  conj 0% (0)
  expletives  0% (0)
```

Figure 4. Results from STYLE

program particularly benefits from the useful distance an inanimate computer occasionally puts between a student and the essay. Consider, for instance, that student in a beginning composition class who writes simplistically on the first topic. Thanks to STYLE, the student typically sees statistical evidence for the problem while the essay is still in draft form: markedly low average sentence length, a high percentage of simple sentences, excessive reliance on *to be*, little variation in sentence length. Before the teacher sees the essay, such students typically revise. To be sure, none of these indexes by themselves is a trustworthy index of quality, but together, they give the student pause, pause that often leads to careful revision both at the sentence level and, inevitably, in content. Conscientious students with little experience as writers especially benefit from such information before handing essays in.

Further, the computer can make analyses that teachers simply cannot. Consider the indices for variety in sentence length, grammatical structure, and type of opening. What teacher can tell students that their percentages of long and short sentences suggest good sentence variety? A teacher with the WRITER'S WORKBENCH system can because the style summary (line 8, figure 4) shows the percentage and number of sentences five words shorter than the average and ten words longer than the average. What teacher has time to make even an impressionistic assessment of the percentages of simple and complex sentences? Again, with the WRITER'S WORKBENCH programs, all students have this information on every paper, and so can revise to avoid long strings of simple sentences or excessive complex sentences. Similarly, the percentage of sentences opening with the subject (line 22, Figure 4) is useful information calling a student's attention to a common weakness in beginning writing.

Finally, the style program gives percentages for passive voice, *to be* verbs, and nominalizations. Passive voice, of course, clogs many an otherwise good sentence; too many forms of *to be* drain the life from even the most thoughtful prose; and nominalizations are a distinguishing mark of wordy and indirect prose. Given the power of this program to analyze a writer's work, CSU students and teachers have found this program among the most valuable of the WORKBENCH. To insure ease of understanding, the CSU version of the WORKBENCH now has a reorganized, simplified, and clarified version of the output from STYLE.

13) PROSE (SYLLABLE and MKSTAND) interprets the STYLE output by comparing it to standards derived from model texts collated by MKSTAND. If, for example, a paper has a significantly higher percentage of simple sentences than the model texts, PROSE tells the writer to consider combining more sentences using subordination. Conversely, if a text has a much higher percentage of complex sentences, the writer receives a message suggesting that more simple sentences would emphasize the most important ideas. If the text falls within one standard deviation from the mean score of the model texts, PROSE notes that the writer has varied sentences appropriately. And so on for a half dozen other variables.

In the CSU version of PROSE, four other programs automatically print lists of words or sentences requiring scrutiny. SYLLABLE gives all words over five syllables long when multisyllable words contribute to a student's high readability grade; the long-sentence program prints all sentences over fifty words long; similarly, the passive program and the nominalization program print all potentially weak sentences when percentages exceed the standard. Long words and long sentences may, of course, be appropriate, but texts often benefit from breaking up sentences over fifty words long and from rewriting to avoid clusters of long words. The passive and nominalization programs, likewise, direct students' attention to important weaknesses. Finally, in the CSU version, PROSE also comments on appropriate mixtures of short and long sentences, percent of *to be* verbs, and average sentence length.

14) ABSTRACT offers an index of abstraction by comparing words in the text against a list of 314 abstract words. If the essay's abstract index is

more than 2.3 percent, the writer receives a message suggesting that the essay probably needs more specific detail. Teachers in the experimental groups found ABSTRACT both a surprisingly accurate guide to a lack of details and a valuable reminder to students of the importance of specifics.

Evaluation

Such programs, we believe, offer a potent weapon against insensitivity to diction and style and against further decline in editing skills. First, even at this early stage of development, they offer a critique that can benefit both students and professionals. Predictably, the initial tests at CSU have shown that students are learning more.[11] As research continues, we can expect even more comprehensive and accurate programs as well as packages adapted to the needs of different writers, whether professional or developmental. As these packages become reality and as other programs join them to cover other parts of the writing process, students can have consistent and thorough attention to the problems of writing from an early age.

Second, the future of software in composition seems positive because most English faculty with no background in computers now consider CSU's programs indispensable adjuncts to classroom instruction. These programs offer so much specific information, especially about style, that teachers now can compliment good work or encourage more work with one-word notes on the printouts. Similarly, thanks to additional revision and correction by students, teachers no longer spend as many hours in rote editing of essays. But interestingly, teachers consider the WORKBENCH valuable, not because they grade papers in less time (most do not), but because by spending less time on surface errors, they have more time for comments on ideas and support. Partly as a result, no doubt, students seem less prone to view the composition teacher as focusing only on matters of lesser importance. Teachers have also noted the value of offering advice to every student at that most crucial stage between the last draft and the final copy. No longer must a student wait a week or more for the teacher to return the marked paper before discovering weaknesses. Some teachers think, too, that because the programs flag real as well as potential weaknesses, because they encourage so many more decisions, students are learning more consistently that they make choices when they write, that good writing is often a matter of goods and betters, not absolutes. In addition, as all teachers everywhere will guess, most teachers appreciate reading perfectly typed copy with margins justified left and right.

Third, the computer seems to offer students a new and better experience while learning. Though we cannot always be certain exactly why this is, real enjoyment seems to have replaced at least some of the drudgery and removed some of the fear about writing. To be sure, computers and terminals are new and different and so have certain inevitable attractions, but other reasons carry more weight we think. These programs address only the specific problems of an individual student. No longer must students work with editing exercises drawn from someone else's paper, from a disembodied someone whose writing problems they have much less commitment to. More important, students feel noticeably at ease with a computer analysis, for the computer is always consistent, rarely misses, never nods. Students also know that it never makes personal comments and that the programs reflect the collective judgment of many teachers, not the idiosyncrasies of a single one.

Just as important, a computer offers a discreet, ever-present assistant who, at the touch of a button, offers suggestions and raises questions permitting improvement in private before a human teacher has seen and marked the essay. No longer must students discover all their weaknesses and errors circled in red. Typing an essay, too, seems to have taken on a different significance. Much of the labor is now gone, and entering the essay into the computer is the first step in strengthening it, not the last step before marking. Once it is entered, moreover, revisions no longer mean retyping the

entire essay, since all corrections can be made on a terminal. In fact, students using computer terminals now enter, edit, run the WORKBENCH, analyze, and print final copy of their essays in about the same time as students in the few remaining "regular" sections—except that students in computer-assisted sections have revised one more time. And should an instructor require another revision, the student has merely to return to the terminal, call up the original essay, make changes and additions, review the editing programs, and again have completed copy ready for marking less than a minute after activating the printer.

For some or all of these reasons, students—with only a few exceptions—feel that computer assistance adds significantly to their enjoyment and learning. Indeed, the computer seems to introduce a certain magic, often missing from this class that requires such great investment of time and energy from both teachers and students. Best of all, the computer offers assistance in improving and in learning how to improve an essay before handing it in. Hard as it was for us to believe at first, we are now convinced that the added enjoyment and learning explains why sixty-eight percent report they would look forward to another composition course if it used computers. Almost as many reported they would pay a dollar an hour and page costs if they could use the terminals to prepare papers in other classes next term.

Cost

Despite every best effort, CSU's project has had no outside funding, yet a $15 fee per composition student will pay all direct costs, including equipment (paid over five years), monitoring, supplies, and repairs. Although Bell Laboratories has shared its software and assisted with test design and statistical analysis, the project is entirely self-supporting, except for an interest-free loan from the university. Other institutions computerizing composition programs can expect to do so for much less still: hardware purchased in August 1981 had come down one-third nine months later. Declining prices for equipment will probably continue for some years yet. Today, the cost for duplicating the CSU project now stands at about one-third the original. Computer assistance now costs far less than a textbook.

Conclusion

During its first three years of use at CSU, the WRITER'S WORKBENCH system enjoyed such success with students, faculty, teaching assistants, and administrators that the project now includes the entire composition program—basic, college, and advanced writing, more than 4000 students per year. Faculty in the College of Business have adapted WORKBENCH for the needs of their students. Faculty in the Intensive English program have adapted it for international students learning English. As the result of a slight increase in tuition, the English Department's Center for Computer-Assisted Writing is now free to all composition students. As the project continues to expand, the laboratory will become a textual-analysis and writing center, soon CSU hopes, open at no charge to all students writing papers for any instructor on campus who agrees to spend lecture, office or grading time helping students with writing problems.

Programs for composition instruction like the WORKBENCH now give writers new power to learn by bringing even the seemingly esoteric and difficult points of style and diction directly to bear on the writer's text. Our experience and that of students at CSU suggest that computers and software will improve the way we write, the way we learn to write, and the way we teach writing.

Notes

1. Lorinda L. Cherry and W. Vesterman, "Writing Tools—The STYLE and DICTION Programs," *Computer Science Technical Report*, No. 91 (Murray Hill, NJ: Bell Laboratories, 1981); Lorinda L. Cherry, "Computer Aids for Writers," *ACM Sigplan Notices*, 16 (No. 6, June 1981), 62-67; "Writing Tools," *IEEE Transactions on Communication*, 30 (No. 1, January 1982), 100-105.

2. Nina H. Macdonald, "Pattern-Matching and Language Analysis as Editing Supports," presented at the Annual Meeting of the American Educational Research Association, Boston, April, 1980; Lawrence T. Frase et al., "Computer Aids for Text Assessment and Writing Instruction," *NSPI Journal*, November 1981, pp. 21-24; Nina H. Macdonald et al., "The Writer's Workbench: Computer Aids for Text Analysis," *IEEE Transactions on Communication*, 30 (No. 1, January 1982), 105-110.

3. Malcolm G. Scully, "The 'Literacy Panic' Revisited: Writing Begins to Mature as an Academic Field," *The Chronicle of Higher Education*, June 22, 1981, pp. 3-4; William Wresch, "Computers in English Class: Finally Beyond Grammar and Spelling Drills," *College English*, 44 (1982), 489-490; Michael E. Cohen and Richard A. Lanham, "HOMER: Teaching Style with a MicroComputer" in *The Computer in Composition Instruction: A Writer's Tool*, ed. William Wresch (Urbana, IL: NCTE, 1984), pp. 83-90.

4. Ruth Von Blum and Michael E. Cohen, "WANDAH: Writing-Aid AND Author's Helper," in *The Computer in Composition Instruction*, pp. 154-173.

5. Lance A. Miller et al., "Text-Critiquing with the EPISTLE System: An Author's Aid to Better Syntax," National Computer Conference, May 4-7, 1981, *Proceedings* (Arlington, VA: AFIPS Press, 1981), pp. 649-655; George E. Heidorn et al., "The EPISTLE Text-Critiquing System," *IBM Systems Journal*, 21 (1982), 305-326.

6. See, for example, Cynthia L. Self, "Wordsworth II: Process-Based CAI for College Composition Teachers" and Christine M. Neuwirth, "Toward the Design of a Flexible, Computer-Based Writing Environment" in *The Computer in Composition Instruction*, pp. 174-205.

7. The idea for CSU's project grew out of a remark by Gearold R. Johnson, Head, CSU Department of Engineering Sciences, that word processors with spelling checkers ought to have some use in teaching composition. The idea became a project when Thomas McCall, Manager, Systems Analysis and Programming, CSU Computer Center, took an active interest in the CSU English Department's programming and system needs.

8. Here, as elsewhere, CSU's project has benefited from the skill and dedication of Blake Stewart, Analyst, CSU Computer Center.

9. Charles R. Smith and Kathleen E. Kiefer, "Using the Writer's Workbench Programs at Colorado State University," *Sixth International Conference on Computers and the Humanities*, ed. Sarah K. Burton and Douglas D. Short (Rockville, MD: Computer Science Press, 1983), pp. 672-684

10. Programmed by David Klein, graduate student, Department of English, who has contributed much to the CSU project.

11. Kathleen E. Kiefer and Charles R. Smith, "Textual Analysis with Computers: Tests of Bell Laboratories' Computer Software," *Research in the Teaching of English*, 17 (1983), 201-214 and "Improving Students' Revising and Editing: The Writer's Workbench System" in *The Computer in Composition Instruction*, pp. 65-82.

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Computer Simulations and the Far Reaches of Computer-Assisted Instruction

Edward B. Versluis

At almost any level of writing and literature instruction, computer simulations offer intriguing opportunities for assistance. Some of the ways in which the powerful English computer simulations of the future can be developed are revealed by current programs. But the best understanding of present and future computer simulations requires a reconsideration of generally held notions about what both computers and simulations can each do well.

Computers as calculators are widely appreciated for their ability to move and manipulate large amounts of data at a great speed. For that reason alone, uses have been found for computers in English as compilers of lists and counters of things.[1] Beyond the number-crunching and storage capacities, however, computers offer their users opportunities to manipulate data in less rapid but more consciously controlled ways. Branching, looping, and recursion permit choices, repetition, and variations—a humble, but very useful set of powers.[2] And the content of these choices, repetitions, and variations need not be solely quantitative.

Still another set of powers can be seen in the capacity of the computer to produce an emotionally rich thinking experience in its audience. This capacity is seen grossly in the riveted attention of the video arcade addicts. At that level, however, the computer has apparently only outstripped the pinball machine and the television set.

If video arcades provide an example of intense experience, psychology provides an example of a complex experience. In the mid-1960's Joseph Weizenbaum created a program, *Eliza*, which "conversed" with its audience by means of a script. In one version of this program, called *Doctor*, Weizenbaum inserted a script that permitted the computer to produce a parody (as he called it) "of a Rogerian (i.e., "nondirective") psychotherapist engaged in an initial interview with a patient."[3] The effect was surprising. Weizenbaum later wrote,

> I was startled to see how quickly and how very deeply people conversing with *Doctor* became emotionally involved with the computer and how unequivocally they anthropomorphized it. Once my secretary, who had watched me work on the program for many months and therefore surely knew it to be merely a computer program, started conversing with it. After only a few interchanges with it, she asked me to leave the room.[4]

This was for Weizenbaum, "clear evidence that people were conversing with the computer as if it were a person who could appropriately and usefully be addressed in intimate terms."[5] It seems a mere quibble to suggest that Weizenbaum's secretary was merely *very* curious. The fact that she felt the need to be secretive about the pursuit of her curiosity is what makes this example striking.

Weizenbaum was bothered by what he perceived to be a "delusion." Literature students, on the other hand, could view this same "delusion" as a fantasy, generated in much the same way that literature and films generate fantasies. If this computer experience is conceived of as a fantasy, then it can

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legitimately be exploited in the service of both instruction and amusement. To do that, however, requires a further consideration of the powers of simulations.

The capacities of the computer have long been used to enhance the capacities of simulations (in fields other than English) with positive results. Not only the hard sciences, but the social sciences too have used computer simulations extensively for well over a decade.[6] What is it about simualations (computerized or not) that makes them so powerful in fields ranging from respiratory therapy to economics?

The answer lies in the conception of a simulation as currently employed. The simplest definition of a simulation I can formulate is: "A simulation mimics the interesting properties of some system."[7] How does it mimic? What properties are interesting? Typically simulations operate according to this somewhat expanded definition: "A simulation is a scaled-down, simplified model of reality; it imitates a dynamic process that occurs in the real world."[8] So the simulation depends upon a model, "representing the important relationships of a process in some other form."[9] But it is also more than a model. Properly speaking, "simulation is the model in operation."[10]

At the heart of each simulation, shaped by its model and in turn shaping its operation, is a problem-solving process, or, in the magic language of computerese, an algorithm. A simulation works by showing how a system handles a problem. What informs the simulation's operation and the observer's understanding is the algorithm, "a specific procedure for solving a particular type of problem."[11] So the algorithm is more important than the solved problem, because it shows *how* to solve the problem.

Current Computer Simulations

When the capacities of both computers and simulations are joined, the potential is substantial, that is, the human mind is free to conceive a simulation so grand that only an incredibly powerful machine could begin to explore the multitudes of its actualized forms. Current practice, of course, is a little less grand than that. Helen Schwartz, in the February 1982 issue of *College English*, reported a couple of computerized poetry-generating programs.[12] From her account it appears that choosing appropriate words to fit into a format or frame is the principal activity of the user. In these simulations, she reminds us, producing "great" poetry is not the only or even the primary issue. There are analytical skills involved, bolstered by the almost limitless ability of the computer to offer its user choices. And both examples are true (or what I call primary) simulations.

Secondary Simulations

Simulations actually come in two flavors, primary and secondary. The most common, the secondary simulation, can easily be illustrated by a simple classroom game. As each team spells words of increasing difficulty, there is a parallel progression up a winding staircase to the high dungeon where the princess (or Alpha Romeo, or a refrigerator full of beer) is imprisoned. Such simulations are sometimes employed as classroom games in elementary schools.[13] They probably introduce some incentive to learn spelling, they are simulations, and they can be computerized. As the computer searches its memory banks for hundreds of words at each level of difficulty, the game can be played over and over. And there may be some improvement in somebody's spelling.

Still, it all seems too easy. This simulation, which we could call "Spell Master of Castle Doom," is a spelling bee in disguise. "Book Master of Castle Doom" could use the same princess in the dungeon parallel, while students tried to guess book titles. Or "Song Master of Castle Doom" could use famous operas, or the top forty Country and Western hits from last week. The activity of spelling words, or remembering book titles, or whatever is only accidentally joined to the simulation of progressing up the castle's staircase. Such secondary simulations (which are only secondary to the choice of material for study) reveal nothing *as simulations* about systems or dynamic processes. This kind of computer simulation does not, therefore, present much

potential for future development.

One last observation about the content of secondary simulations. Spelling, book titles, images, metaphors, symbols, and historical or biographical facts all involve mental tasks of equation: "These letters in this order equal that word. This object is the image of that idea. This historical event is the equivalent of that scene." To successfully complete the intellectual task required in each play, the player need only recognize the other half of the equation. Concepts that can be handled in this fashion we can appropriately term static, not systems or dynamic processes.

Primary Simulations

Primary simulations, on the other hand, use their content in part to determine their own form. That is, primary simulations require the subject matter itself to be appropriate for simulation. Subject matter or content which involves systems or dynamic processes can best be understood in terms of dynamic structure, a system of cause-and-effect relationships. Simple equations involving static concepts will not serve primary simulations because the static concepts (such as spelling, images, metaphors, symbols) do not describe cause-and-effect systems, things that twist and turn, intensify or develop as they progress.

What kind of subject matter *is* dynamically structured? One of the simplest examples I can think of is the paragraph. Composition textbooks in the last few years have pretty well covered the ground about how a topic governs the development of paragraphs whose structure may involve examples, growing intensification, chronology, or cause and effect. In fact, those same textbooks and others have gone on to describe how the same or elaborated structures govern whole essays.

The Penguins of Death is a simple paragraph-ordering simulation which was demonstrated at the College Conference on Composition and Communication in Detroit in March 1983.[14] Here a secondary simulation, reconstructing a letter, serves as an incentive to sort out and then reorder a group of sentences into two well ordered paragraphs. During the sorting phase of the program, sentences concerned with Dick's job, using "he" or "his" or describing the training of attack penguins, are gathered together. Similarly sentences dealing with Loretta's job, using "she" or "her" or describing the rehabilitation of criminal penguins, are isolated. One sentence fails to fall into either category. It is allowed to remain unassociated until later when, during the ordering of Loretta's paragraph, "gooey immobility" is revealed to be the grim consequence of a shot from her bubble gum gun (sorting by connotation and ordering by cause and effect). This simulation is currently being upgraded to become one step in a package consisting of an involved murder conspiracy as the secondary simulation and various increasingly abstract forms of organization as the primary simulations.

The skill being taught in these lower-level organizational simulations is one which we all use casually when going over a student's paper in an office conference. The computer in the simulations moves the sentences into groups and finally into patterns in a kind of predestined word-processing episode.

At the short-essay level, *Aunt Sadie's Gift* is a thank-you primary simulation.[15] On the surface the problem-solving situation appears to be simply a matter of expressing the most gratitude that can be mustered for the Christmas gift of a frozen (now thawing back to life) rattlesnake. But Aunt Sadie's gift is more than a mere six-foot-long rattlesnake. She has also written a warm, homey letter to the person she remembers as "Bubby." The snake was specially chosen as appropriate for "Bubby's" interest in natural science. So her gesture, the special present and the warm memories she recalls of a childhood visit to the ranch, constitute a substantial gift indeed. More than a perfunctory thank-you is called for.

This analysis is not part of the simulation, but should be evident to most readers of Sadie's letter to "Bubby." Instructions immediately follow Sadie's letter as it scrolls up the screen. They add that you (the reader, now in the role of "Bubby") really did enjoy your stay on the

ranch when you were six, and that Aunt Sadie and Uncle Billy are very sensitive people, easily hurt. To assure positive orientation of writer toward audience, a safety net, in the form of a dash of avarice, is added: they have a lot of money and no children.

Those additions still only produce a situation where you as the writer should make every effort to convey all the honestly felt gratitude for the snake. But, as in real life, there are complications. First, you long ago lost interest in natural science. Now you are in your third year at Chef Lasagna's School of Gourmet Cooking in Grundy Center, Iowa. Also nobody has called you "Bubby" since you were six years old. You *hate* the name "Bubby."

What is simulated here, therefore, is a situation combining apparent opportunities (expression of gratitude, recall of happy memories) and obstacles (dangerous snake, change of interests, "Bubby"). Part of the algorithm for handling such a situation is the knowledge that the obstacles frequently can be converted to opportunities. Not a few students translate gratitude for the snake into their first chance to impress the cooking class with that old favorite, "Sadie's Snake Surprise Soufflé."

How the simulation generally operates can be seen in the choice of an appropriate salutation. Several possible ones are displayed, and as the user/letter-writer's choice is entered, it appears by itself on a subsequent screen accompanied by a comment, which may applaud the choice, offer some reason why it was particularly good, or press beyond criticism to sarcasm. The degree to which such comment can productively serve as critical companion, at times supportive, at times bandying, needs further study. So far reactions to the commentary in an earlier version of *Aunt Sadie* range from "unobtrusive" to squeals of delight (dependent, of course, on age and level of education).

After the salutation a pre-writing section allows the user to determine which and how many subject areas (memories of Christmas on the ranch, change of interests, etc.) are to be dealt with, and what order in which to deal with them. Then arrays of actual sentences are offered, each choice appearing as part of a now growing letter with a comment on its role in that letter.

Among dozens of acceptable (*not* necessarily impressive) thank-you letters, any one can thus be written to Aunt Sadie. A similarly designed simulation lets the user rewrite a complaint to the Acme Cannon Company. *Buccaneer Billy's Bad Bargain* involves, first, the analysis of what problem Billy is trying to solve in his garbled version. The successive sentence arrays permit a reasonable, businesslike, and thorough handling of the situation.

The algorithm for thank-you and complaint letters, the format and constraints for such problem-solving, has been worked out in composition texts and especially in technical writing texts of the last couple of decades. That accomplishment makes composing computer simulations at this level relatively easy. We are currently planning a several-part project, called *The Salvaging of Object C-9*, involving feasibility studies, memos requesting action from various units, and a final report on the removal of a city-size archeological find from a dying planet in the Andromeda Galaxy.

Future Computer Simulations

What directions should computer simulation development take in the future? One area already implied is computer commentary, for which simulations are a particularly rich testing ground, because they involve progress through a defined experience. Writing-process programs like *Aunt Sadie* use immediate and frequent commentary to nudge the student as the essay takes shape. Identifying a proper "voice" is a real issue with such programs. While many teachers would disapprove of a flat "That's wrong!" as computer-abusive, what about "Thank you so much for sharing that input with us"? Of course, this issue should not be settled in terms of simply correct voice. Think of the possibilities of a program whose voice maliciously lied to the student, and whose reward at the end would be the deceiver's identity. If the unmasking constituted some

understanding of literature which the student had wrested from the program, we would have a rich and educational tool indeed.

But there are areas outside the teaching of English which are likely to influence the future of English computer-simulations. In a leading computer magazine a recent review of *Planetfall*, a home computer game by Steve Meretzky, makes a provocative observation:

> While a number of people are struggling to bring literature to the computer via hybrid short stories, interactive fiction, and other new forms with varying degrees of unsuccess, the old adventure, being honed and refined and filled out, is getting there first.[16]

Game theory, games in education, even simulation gaming have been around for some time. John von Neumann and Oskar Morgenstern did seminal work in game theory for economics in the 1940s.[17] Kenneth Davis and John Hollowell edited an interesting book on games for English in 1977. In that book they even suggested that "perhaps, the richest sources of potential games lies in computer technology.'[18]

Without writing extensively about the rich potential I see in gaming, I would like to register one reservation I have about it in the future. Most educational games are designed to have an effect on student attitudes toward learning.[19] Most studies of their success have been done in elementary and secondary schools, where student attitudinal problems are notorious.[20] The two-faced element of competition/cooperation is primarily responsible for altering student attitudes in that environment. To the display of the material to be learned, games add the requirement that someone always win or at least achieve a comparable success. Winning isn't everything in a game, but it's a lot.[21]

To take one example, one of the most influential descriptions of game design, beginning with defining objectives and carrying all the way through to debriefing the players, consists of ten steps. At least seven of those ten steps are determined by or influenced by the competitive nature of the enterprise.[22] As computer simulations grow more complex, I suspect that the addition of competitive features will become an irritating encumbrance. Also, it may turn out in the long run that competition is not as appropriate for unfolding the skills of writing a novel as it is for winning an election or stamping out an epidemic.

One feature which games of all sorts share with simulations is problem-solving, which requires an active involvement on the part of the student user. That advantage over passive reading as an instructional means, coupled with the unreasonable enthusiasm students often show for CAI, suggests a rich area of investigation. The intense concentration of players in video arcades, the depth of feeling in the Weizenbaum anecdote about the program *Doctor*, and the firm attachment of students to even mundane computer tasks, all share to a greater or lesser degree one quality—they all involve what has been called a "flow activity."

The concept of a "flow activity" was first presented in an article by Mihaly Csikszentmihalyi entitled "Play and Intrinsic Rewards."[23] I quote his description:

> . . . the various elements of the flow experience are inextricably linked together and dependent on each other. By limiting the stimulus field, a flow activity allows people to concentrate their actions and ignore distractions. As a result, they feel in potential control of the environment. Because the flow activity has clear and noncontradictory rules, people performing it can temporarily forget their identity and its problems. The results of all these conditions is that one finds the process intrinsically rewarding.[24]

Without digesting that description, you can hear echoes of an experience we all enjoyed, being absorbed in a really good book. If there is something to the notion of a flow experience or activity, we should find out more about it. The consequences are considerable. Csikszentmihalyi concludes, "These considerations suggest that it is possible to order structured activities and situations in terms of whether they are more or less intrinsically rewarding, depending on the intensity of flow they allow a person to experience."[25] That is, it is possible

for us to consistently shape a learning experience solely in terms of the power generated by the learning pleasure itself, and to do so for quite a broad audience.

The future for computer simulations I am predicting will consist of increasingly ambitious attempts to imitate dynamic processes of creating and understanding literature. The key to success in those attempts lies not in computer hardware development, or even programming itself, but in the basic concepts describing the dynamic structures we associate with literature. Understanding the adequacy and limits of the models we use in simulations, as well as the nature of qualitative inputs and outputs, requires that they be expressed in very explicit terms.

A word of explanation is in order. The information you supply to a functioning computer program is called input. The information the computer in turn supplies to you is called output. While you probably already know that, what you might not know is that computer simulations use two different kinds of input/output. When the field of the simulation involved is physics, the relationships that form the model come from the theories that currently govern that science. Consequently, the operation of a physics model is expressed in terms of numbers, the numerical values of the physical processes. Numerical values in a computer simulation are called quantitative inputs and outputs.

In a field like English, quantitative inputs, mere amounts, are denied to us because our understanding of literature is generally not quantitative. The information the user supplies and receives in return from an English computer simulation will usually be statements in English reflecting judgments, that is, qualitative inputs and outputs.[26] Enabling the machine to handle those statements, providing the foundation in a very explicit and clear set of propositions, will require reworking some of our favorite concepts in literature. For example, the concept of plot (more than just a string of events) often involves notions of a dynamic structure. But the lack of explicitness in most discussions of plot renders them unworkable with the unforgiving machine.

Aside from the obvious value of refining the critical tools we work with, what kind of instructional aid are we ultimately aiming to produce? Imagine that Aristotle and Shakespeare, two souls with firm convictions about tragedy, determine, during their long sojourn in the Elysian fields, to write some plays in partnership. Each is willing to listen to the other's ideas, but lest they become contentious, they elect a third party, you, to make choices at each stage in the writing. First Aristotle trots out his conceptions of Fable, Character, Thought, Diction, Melody, and Spectacle, and then Shakespeare arrays three working examples, *Richard III*, *Julius Caesar*, and *Macbeth*. What would the two masters say to each other? And when they disagreed, what would the consequence of your intervention be? Preparation for such projects will necessarily involve long hours spent in the most conventional sort of careful research and analysis. And it will also involve writing more computer simulations.

Research simulations have been around for as long as instructional simulations.[27] And research simulations, centered on the problems of one kind of artistic choice within a system as complex as a drama, could serve as powerful heuristic devices. What you already know goes into the construction of the research simulation. Running the simulation then takes you beyond what you know and into new territory.

The possibility of this kind of project raises the most serious sorts of questions for us as teachers and researchers. Today we face another of those terribly important choices about the appropriate use of a new technology. Embracing computer simulations no doubt implies changes in the way we teach which this article has not touched upon. But there are enough clearly identifiable advantages to justify optimism that computer simulations will play a major part at the far reaches of computer-assisted instruction.

NOTES

1. S.Y. Sedelow in "The Computer in the Humanities and Fine Arts," *Computing Surveys*, June 1970, pp. 93-96, describes three typical uses that had been found for the computer by that time. The first was the compilation of word choice indexes and concordances for authors ranging from Emily Dickinson to Racine. Another was a detailed analysis of *Roget's International Thesaurus* on the basis of analyses of other thesauri and synonym dictionaries. The last was a frequency graph produced by counting the "words designating images" in several 500-word sequential units of James Joyce's *A Portrait of the Artist as a Young Man*. That such computer applications continue is seen in a recent article by Rudy S. Spraycar and Lee F. Dunlap, "Formulaic Style in Oral and Literate Poetry," *Perspectives in Computing*, 2, No. 4 (December 1982), p. 24-33.

2. *Branching* usually involves the selection between which of two or more alternative steps will be carried out next. In the context of this paper, branching will be strongly equated with human (as opposed to mechanically calculated) choice. *Looping* involves repeating some operation, perhaps several or an indefinite number of times. In human experience (even with a computer simulation) this may mean little more than a repeated examination of something. *Recursion* also involves repetition of some operation, but in altered circumstances. In human terms it would be typified by asking, "What are the most important elements in this situation?" as one came into each new situation.

3. *Computer Power and Human Reason: From Judgment to Calculation* (San Francisco, W.H. Freeman and Company, 1976), p. 4.

4. Weizenbaum, p. 6.

5. Weizenbaum, p. 7.

6. One early discussion of the use of computers to simulate higher mental processes is Walter R. Reitman's "Heuristic Programs, Computer Simulation, and Higher Mental Processes," *Behavioral Science*, 4 (1959), 330-341. By 1971 Nico H. Frijda was able to write, "Computer simulation of psychological processes has proved itself an important tool in the development of psychological theory," in "Problems of Computer Simulation," in *Computer Simulation of Human Behavior*, ed. John M. Dutton and William H. Starbuck (New York: John Wiley & Sons, Inc., 1971), p. 610. Two examples of the application of computer simulations to macroeconomics are Thomas R. Kershner, "The Uses of Computer Simulations in Teaching Macroeconomics," in *Proceedings of a Fourth Conference on Computers in the Undergraduate Curricula*, 18-20 June 1973 (Claremont CA: Institute for Educational Computing, Claremont Colleges, 1973), pp. 155-159, and Robert Schenk, "Simulating the Great Depression in Introductory Macroeconomics," in *Proceedings of National Educational Computing Conference*, ed. Diana Harris (Iowa City: Weeg Computing Center, University of Iowa, 1979), pp. 179-188. Famous (in computer simulation circles) is "Bonini's Paradox," involving the problem of creating a simulation so detailed that it is as unwieldy as the phenomenon simulated, which was first stated in a book on systems in business, C.P. Bonini, *Simulation of Information and Decision Systems in the Firm* (Englewood Cliffs NJ: Prentice-Hall, 1963).

7. I am indebted to Ivan Tomek's *The First Book of Josef: An Introduction to Computer Programming* (Englewood Cliffs NJ: Prentice-Hall, 1983), p. 26, for the expression "interesting properties."

8. Kenneth Davis and John Hollowell, eds., "Foreword," in *Inventing and Playing Games in the English Classroom: A Handbook for Teachers* (Urbana IL: National Council of Teachers of English, 1977), p. v.

9. Robert E. Horn, ed., "Model," in *The Guide to Simulations/Games for Education and Training*, 3rd ed. (Cranford NJ: Didactic Systems, 1977), I, 6.

10. Richard S. Lehman, *Computer Simulation and Modeling: An Introduction* (Hillsdale NJ: Lawrence Erlbaum Associates, 1977), p. 5

11. Horn, "*Algorithm*," p. 6.

12. "Monsters and Mentors: Computer Applications for Humanistic Education," *College English*, 44 (1982), 145-146.

13. Three such secondary simulations, "A Novel Approach," "Take 'em Out to the Ball Park," and "Snail Game," appear in *A Sampler from the NCTE Idea Exchange*, ed. Audrey Hodgins (Urbana IL: National Council of Teachers of English, 1981), pp. 44, 59.

14. In this example and some of the others, credit should go to Charles R. Ryberg as coauthor, for spending months on every aspect of the work from details like program subroutines to general issues like educational significance.

15. Written with Ryberg.

16. M.C.T. in "Marketalk Reviews" in *Softalk*, 3 (Aug. 1983), 164.

17. *Theory of Games and Economic Behavior* (Princeton: Princeton University Press, 1944).

18. Davis, p. 45.

19. See Clark C. Abt, "Games for Learning" in *Simulation Games in Learning*, ed., Sarane S. Boocock and E.O. Schild (Beverly Hills CA: Sage Publications, 1968), p. 74; Clark C. Abt, *Serious Games* (New York: Viking Press, 1970), p. 18; Dennis M. Adams, *Simulation Games: An Approach to Learning* (Worthington OH: Charles A. Jones Publishing Company, 1973), p. 7; John Condry, "Enemies of Exploration: Self-Initiated Versus Other-Initiated Learning," *Journal of Personality and Social Psychology*, 35 (July 1977), 459-477; Davis, p. 3; Thomas H. Malone, *What Makes Things Fun to Learn? A Study of Intrinsically Motivating Computer Games* (Palo Alto CA: Xerox, Palo Alto Research Center, 1980); Frank H. Rosenfeld, "The Educational Effectiveness of Simulation Games: A Synthesis of Recent Findings" in *Gaming-Simulation: Rationale, Design, and Applications*, ed. Cathy S. Greenblatt and Richard D. Duke (New York: John Wiley & Sons, 1975), p. 286; John L. Taylor and Rex Walford, *Simulation in the Classroom* (New York: Penguin Books, 1972), p. 34.

20. Condry; David L. DeVries and Robert E. Slavin, "Teams—Games—Tournaments (TGT): Review of Ten Classroom Experiments," *Journal of Research and Development in Education*, 12 (1978), 28; Ray Glazier, *How to Design Educational Games*, 4th ed. (Cambridge MA: Abt Associates, 1969), pp. 2-3; Alice Kaplan Gordon, *Games for Growth: Educational Games in the Classroom* (Chicago: Science Research Associates, 1972), pp. 34-35.; Rosenfeld, pp. 285-291; Serwin A. Steffin, "Come In and Play with Me (Computer Simulations: A Key to Divergent Thinking)," *Media and Methods* (October 1981), pp. 12-13.

21. Adams, p. 25; Elliott M. Avedon and Brian Sutton-Smith, *The Study of Games* (New York: John Wiley & Sons, 1971), p. 7; DeVries, pp. 29-30; Gordon, p. 21; R. Duncan Luce and Howard Raiffa, *Games and Decisions* (New York: John Wiley & Sons, 1957); Guillermo Owen, *Game Theory* (Philadelphia: W.B. Saunders, 1968), p. 2; Dale Peterson, *Big Things from Little Computers: A Layperson's Guide to Personal Computing* (Englewood Cliffs NJ: Prentice-Hall, 1982), p. 146; Edwin Rausch, "30,000 Ways to Invent Your Own Group Games," in Horn, p. 534; Martin Shubik, ed., *Game Theory and Related Approaches to Social Behavior* (New York: John Wiley & Sons, 1964), p 8-13. One discussion stands virtually alone in pointing out (quite rightly) that some "games" involve elaborate agreements among the participants to behave *inefficiently*. This argument is presented in R. Garry Shirts, "Notes on Defining 'Simulation'," in Greenblatt, pp. 75-81.

22. The ten steps were initially defined in Clark C. Abt's *Serious Games*. When later repeated in 1973, by Ray Glazier in the fourth edition of *How to Design Educational Games*, the competitive element is quite clear.

23. *Journal of Humanistic Psychology*, 15 (Summer 1975), 41-63.

24. Csikszentmihalyi, p. 55.

25. Csikszentmihalyi, p. 60.

26. "*Qualitative Outcomes*," in Horn, p. 6.

27. Frijda argues that computer simulations can serve "as unambiguous formulations of a theory" or as "a means to demonstrate and test the consistency and sufficiency of a theory," and "may serve as a heuristic in the search for models" (p. 610). Linda Garmon reports that, to discover the future potential nationally of

photovoltaic systems, a computer simulation "simulated augmenting Mid-Atlantic and Southwest utilities with a residential, flat-paneled, passively cooled silicon array that converts sunlight into electricity," in " 'Watt' Photovoltaic Systems Can't Do," *Science News*, July 18, 1981, p. 39. Joseph F. Hanna proposes validity criteria for simulation models in "Information-Theoretic Techniques for Evaluating Simulation Models," in Dutton, pp. 682-692. Richard S. Lehman expresses one of his central concerns, "Computer models and simulations are often the outgrowth of theory, and developing a simulation from a (usually verbal) theoretical statement has several potential advantages," in *Computer Simulation and Modeling: An Introduction* (Hillsdale NJ: Lawrence Erlbaum Associates, 1977), p. 11. The title of Reitman's article (already cited) makes clear his use of computer simulations: "Heuristic Programs, Computer Simulation, and Higher Mental Processes." Weizenbaum points out that theories in regular language may appear quite eloquent. However, "computer programs tend to reveal [those theories'] errors quickly and sharply" (p. 152).

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Computer-Assisted Learning for School Pupils of History, French and English in the UK

Deryn M. Watson

There has been a significant change in the environment for Computer-Assisted Learning (CAL) in the U.K. since 1980. Two government initiatives have successfully brought computers to the forefront of the teaching profession. In 1981 the Department of Education announced the Microelectronics Education Programme with the declared aim of ensuring that all pupils leaving school, whether at sixteen or eighteen years, should be familiar with computers and their potential applications [1]. This program (initially to run until 1984, but recently extended to 1986) has concentrated its efforts in three directions:

1. the development of an information network across the nation, based on 14 regional centers to cover all aspects of information flow about what is happening in the field of computers as it affects schools.
2. the introduction of a series of in-service training initiatives designed to introduce to the current teaching population an understanding of computers and their potential; this has recently been enhanced by a pre-service program.
3. the development of appropriate software for use in schools.

This paper will examine aspects of this third section, with particular reference to the Computers in the Curriculum (CIC) approach. Promoting national computer awareness in an environment that was not computer rich was not without difficulties. In 1979 it was estimated that roughly 5% of all secondary schools in the U.K. had access to computer facilities, often by a batch service, or telephone link to local government offices or a tertiary college.

Accordingly another arm of the U.K. government, the Department of Industry, responded with a parallel scheme in 1981 for the acquisition of micros by all schools through a matched funding scheme between the government and individual schools [2]. Over the last three years further offers have been added to this initial scheme, so that schools should have available to them at least 32K of memory, high resolution graphics, color boards and monitors, with the possibility of peripherals such as printers, graph pads, remote sensors and even a TURTLE-style device. Thus the stage is appropriately set for the introduction of CAL materials in the school.

Nevertheless, the position of the humanities was not automatically strong. The MEP strategy document emphasized that "the Programme will give priority to applications in mathematics, the sciences, craft/design technology, geography and courses related to business or clerical occupations" [1]. Neither the social sciences nor humanities (a term which in the U.K. on the whole covers both aspects) appeared to be in the forefront of the minds of the MEP Directorate. Nevertheless, humanities have always been an integral part of the Computers in the Curriculum Project [3], based at Chelsea College, which has been working since 1973 on the investigation and development of computer-assisted learning materials in history,

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geography, economics, biology, physics and chemistry, for use in secondary schools [4]. It has followed a clear philosophy that sees CAL as a component of the total curriculum [5]; the justification for using a computer in the classroom being that it should enhance or even extend the current teaching practice, rather than merely replace one methodology with another. To this end it has evolved a model for the production of CAL material that embraces teachers, programmers and CAL designers [6]. This ensures that imaginative, innovative teachers who are still in the classroom work as a team with professional programmers and Project members who are becoming specialists at issues of CAL design.

Style of CAL

All the work in a variety of disciplines had concentrated on the investigative approach, based on a belief that the computer was best used interactively, with the pupil responding to the directions which each response suggested. With one exception, a history CENSUS data base (see below [7]), the Project's philosophy accordingly had kept it away from developing large drill and practice routines or large data bases. This style suggested that there was often no single or correct path of learning, but rather a system which the user was invited to explore. A particular style of programming developed, which even though based on BASIC, reflected a user-friendly approach and the need for the pupils to explore the program, often through a variety of options.

Naturally, many of the resultant materials were simulations which can provide incentives for many pupil investigations. They are particularly powerful in facilitating the exploration of areas hitherto inaccessible to the pupil because of expense, time, impracticality, or danger. Thus we see in science such simulations as that of the decaying of radio-active material, or the fish life in a pond; in the social sciences, we see the exploration of a fiscal policy model or the examination of potential population growth via a population projection model. An added strength of simulations is that in their design and development they force the teachers/developers to prepare an accurate model to be exposed to examination, rather than merely rely upon the generalization they have been forced to use in the past. This condition imposes on the developers a severe but educationally exciting responsibility to understand and examine in detail the nature of the models they have used so frequently in their teaching.

The basis for CIC's CAL development through the use of simulations has been upon the heuristic principles of learning, with the pupils placed firmly in the role of the driver. They are constantly encouraged to explore the environment which the software presents to them, and to ask the question "What would happen if . . .?" What would happen if I changed the birth rate? What would happen if I increased the temperature? What would happen if I overfished the pond? Recent work in the social sciences part of the Project has extended this question towards an emphasis upon the decision-making aspects of such CAL style and design [3]. What shall I do . . .? The responsibility is the pupil's, not just to explore a set series of variables, but to decide the most appropriate variables and path of action. Encouraging the question "What shall I do?" has implications for both the CAL developer and the style of learning being fostered [8].

Work in History

An example of the Project's philosophy in operation may be seen in some of the history CAL under development. Since 1973 the historians, working along two main channels of interest, have produced a large data base to enable history pupils to interrogate the 1851 census material [8], and explored the possibilities of decision-making simulations. The latter tackled the problem of allowing pupils, without enabling them to "change history," to investigate the background behind key decisions that were taken. Thus both CAMPAIGN [9] and CHOICE [10] provide an opportunity to explore the reasons behind key decisions by placing before them the options that were faced by Edward I in his campaign leading to Crécy in 1415, and by Disraeli during the Balkan Crisis of 1875-78.

In 1981 the Project began working in close co-operation with a history curriculum project, the Schools Council History 13-16 Project [11], which has had a key influence recently on the style of history teaching in U.K. secondary schools. This collaboration was in line with the strategy to ensure that our CAL always reflects the moving curriculum in each discipline. The emphasis is on the development and appreciation of history methods, and analysis of local history records, an appreciation of the problems produced by conflicting evidence, and an ability to pose hypotheses and test them against the known evidence. Working with teachers who were familiar with the history 13-16 syllabus, the CIC Project aimed to design CAL that would reinforce their historical philosophy. The six units produced by this working group are currently on trials in schools and will be published later in 1984, with a further six specifications in the pipeline.

ARCHEO [12] is a program that aims to show pupils how difficult it is to secure an exact picture of the past and a chronological sequence of events. The pupils are presented with an archeological dig, its time scale limited by impending motorway construction. From a grid, they have to choose which squares to dig, and can dig shallow or deep trenches that hit bedrock. If finds are uncovered (e.g., some animal bones, pieces of pottery, or axe heads) they must decide on what they think the object represents (old temple, furnace, gateway?) and the period to which it might belong. At the end of the time period they may have uncovered about a third of the site and will have to make some sense of the evidence they have secured. This difficult exercise is useful to emphasize the nature of history itself, that is, that facts do not simply appear in textbooks, but have to be found and verified, and a hypothesis explored as to their significance. The pupils can run through this unit many times, exploring with different combinations of trenches, and at the end no one may be able to state with certainty the actual history of the site.

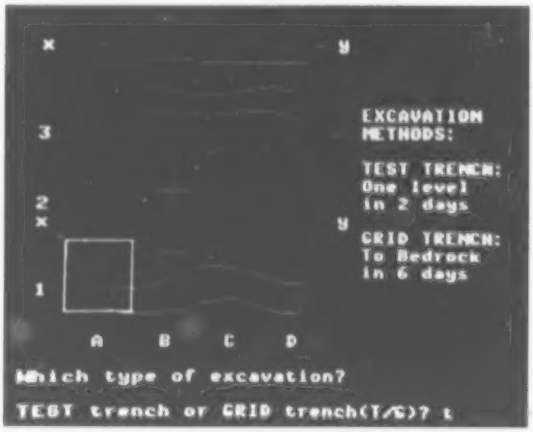

Figure 1. The plan form of ARCHEO, identifying where to dig.

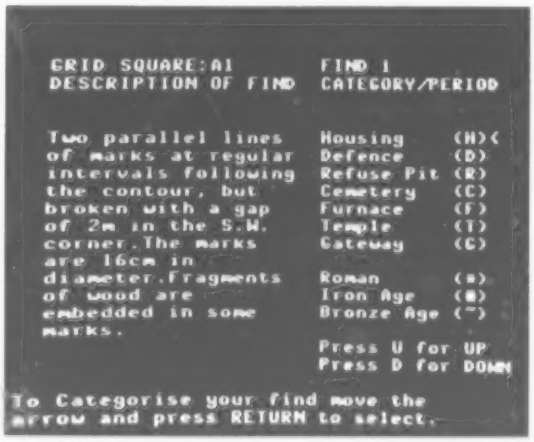
GRID SQUARE:A1
DESCRIPTION OF FIND
FIND 1
CATEGORY/PERIOD
Two parallel lines of marks at regular intervals following the contour, but broken with a gap of 2m in the S.W. corner.The marks are 16cm in diameter.Fragments of wood are embedded in some marks.
Housing (H)
Defence (D)
Refuse Pit (R)
Cemetery (C)
Furnace (F)
Temple (T)
Gateway (G)
Roman (R)
Iron Age (I)
Bronze Age (B)
Press U for UP
Press D for DOWN
To Categorise your find move the arrow and press RETURN to select.

Figure 2. Identifying finds from their basic description.

ARCHEO exemplifies the exploratory nature of much material developed by the CIC Project. With no defined "answer" at the end, it is meant to be used by the pupils themselves rather than demonstrated by the teacher as an electronic blackboard, and is designed to stimulate further thought and understanding of the discipline being studied.

The Basis of the Language Feasibility Study

The Computers in the Curriculum Project received an injection of funds in 1981 from the MEP, one particular aspect of which relates to this paper. Although the Project was confirmed as a major national center for the production of CAL in the areas it was already investigatin , it was also funded for a study of the feasibility of CAL in languages. This was a new departure, for the Project had no language expertise within its central team. It was indicated by MEP directorate that the purpose of engaging us in this language feasibility was to literally take the skills developed for software design issues in history, geography and economics and see if they could be applied to CAL in languages. Following the clear imperatives of the Project's philosophy and model for work, it was important to find out what was currently happening in the language teaching curriculum in schools, and seek teachers and advisers to be actively involved in the work. Beginning in 1981, the first six months of the feasibility study were taken up by discussions with the various bodies which would give a view on the current state of the curriculum: such bodies as Her Majesty's Inspectorate, local authority advisors, the national subject associations, and the Schools Council, at that time a key body in the generation of discussions and projects on the curriculum and examinations, and between 1973-82, the major funder of the Computers in the Curriculum Project.

Language teaching in the U.K. falls into two distinct camps, foreign languages and English, and associated studies of literature are similarly divided. An interesting point that emerged from the discussions, however, was the similarity of concerns which are currently at the forefront of language curriculum thinking. Thus the issue of communication and the development of communicative skills within a variety of media appeared to hold a central position compared with aspects of grammar and structure or general linguistic analysis. Even without a comprehensive view of language teaching in the U.K., pointers which were followed in directing this feasibility study can be of interest and value.

First, the lobby that was speaking so loudly for the communicative approach met an ally in the Project, which had not developed a style of CAL and programming suitable for establishing linguistic, grammatical accuracy, or cloze procedures. Clearly designed and managed paths of learning require a type of programming language with which the Project was not familiar. Packages to reinforce the learner's grammatical and structural understanding of language did not accord with the investigative approach. A concern for communication rather than accuracy would lead more naturally to an extension of the approach developed for history and other subjects. Yet a review of materials that were then under development for language teachers suggested that the computer was being exploited chiefly as an accuracy tester [13]. A conference held in the autumn of 1983 indicated that in the foreign language community, this is still the majority position [14].

Language teachers who would become involved in one of the development groups were usually difficult to convince that the computer had anything to offer beyond cloze procedures or word processing. Although the project feels that word processing will be an invaluable aid for schools in the future, it deliberately avoided spending any time on such a general-purpose package in order to concentrate all its attention on communicative language teaching.

The Foreign Language Work

With the development of language laboratories in the 1960s, the foreign-language teaching community received much attention. Many schools placed a high premium on second-language learning, so that in some schools second languages were taught for nine periods out of forty. Unfortunately this enthusiasm was replaced by disillusionment in the 1970s, partly because of timetabling issues and room allocation. Inflexible schedules led to negative judgment on the quality of the resource itself. But the central question should not have been the availability of the facility; pupils became bored with the relative tedium of some of the tapes. The quality and quantity of material available for use in the

laboratories had not been adequately planned or developed. Where CAL was proposed, therefore, there was good reason for language teachers to be skeptical about using another piece of educational technology, especially when the twin dangers of poor quality and a small quantity of software made the parallel with language tapes all the more pertinent. A considerable obligation was placed on the project to overcome such skepticism and provide them with some worthwhile CAL.

From the disillusionment in the mid-seventies emerged the Graded Test movement. Firmly committed to the communicative approach, its protagonists sought to remove language teaching from the heavy burden of "learning the rules" before you could apply them to a living language. Instead they wished to encourage a sense of success at communicating effectively throughout all the stages of language learning. To this end it was more important that pupils should feel confident after only one year of learning French to cope in a variety of situations in France even though their sentence structure might not be perfect. As long as they could understand enough and communicate with the French, the principal object would have been achieved. Such communicative objectives were separated, or graded, into a series of tests, whose levels were used as guidelines as the pupils progressed up the school.

In a sense these language-graded tests are similar to grades in music; for years pupils have learned competence at playing an instrument from initial teaching. They spend less time on the rules and most time on the accomplishment. The graded-test movement says that verbal and written communication is an accomplishment to be placed higher than an academic understanding of the structure of the language.

A cooperative venture to explore the possibilities of CAL development within such a language learning framework was proposed to one center for such graded test work, in Lancashire and Cumbria in the North West of England and based on St. Martin's College, Lancaster. Because there was no exemplar material to illustrate the possibilities of CAL beyond spelling-checking tests, these French teachers instead worked their way through a geography CAL exercise, a game about sitting six windmills on an island [15]. Once thoroughly absorbed in the task, where the computer provided results of the choices incorporating the availability of wind, distance from farms and distance to the bakery, they were receptive to the idea of using a CAL exercise for applying theoretically acquired knowledge to a practical situation. The French teachers knew nothing about a weight-losing industry at the beginning of the exercise; at the end some clear learning points had been gained.

Thus encouraged, the teachers were willing to engage in lateral thinking and attempt to apply such an approach to language learning. Projects programmers were attached to the writing group and a series of exploratory meetings held, during which the programmers learned about the language-teaching concerns while the teachers learned about the machines, their own capabilities and the accuracy needed in specifying their requests to the programmers. From such meetings some clear ideas for programs emerged. These have since been developed, and tested in schools, and the first batch will be published shortly.

A Sample French Program

COPROB [16] is a simple program for the Level 1 pupil (eleven years old) who needs to recognize the French words for various shops and facilities in town, e.g., *pharmacie* and *hôpital*. Rather than simply being given a list of the words and asked to choose or type the correct one, the pupil is asked to engage in a search for four criminals on the run from the police, each of whom is looking for something to steal. Knowing that one criminal is searching for food, the pupils must choose an appropriate location, for instance *hypermarché*. Twelve locations are presented to the user as a printed list, and also as symbols on a town map. This latter aspect is important, as pupils need to recognize the signs and symbols commonly used to represent such features as a chemist or bank. The crimi-

nals are moved randomly around the appropriate locations, so that the success of the police depends on chance as well as the pupil choosing an appropriate location. Once a word is chosen, the screen shows the town map with the Commissariat from which the police car emerges to track down the criminals.

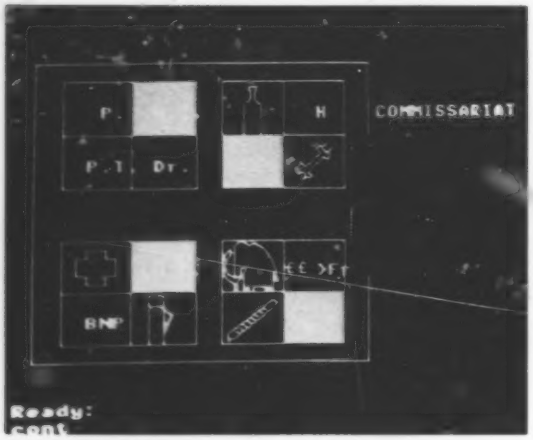

Figure 3.
The town plan from which the pupils need to locate the criminals.

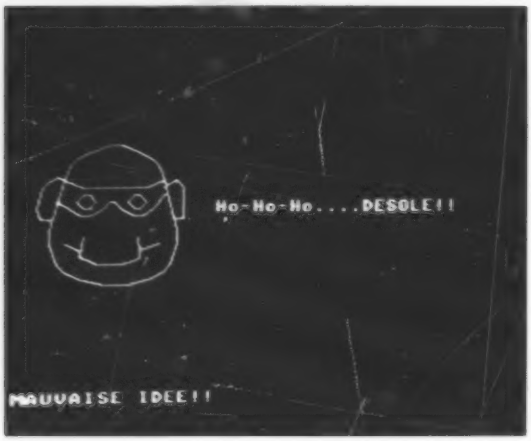

Figure 4.
The message when pupils have chosen an inappropriate location.

Key Issues in This Style of Language CAL

This style of CAL, it was discovered, could easily fall between two stools: not thoroughly drill-and-practice, it was also not designed to trap all the possible errors in one answer. The answer needed to be right or wrong; if the latter, the pupil was given one or two more chances to get it right, and then told the answer. There were no diagnostic facilities built in, nor spelling traps to inform the pupil that the word chosen was correct, but poorly spelled. Also experienced was an enormous frustration at the need to use words in the written rather than aural form, and disappointment with the state of voice input/output. Still, trials of the first materials indicated that the pupils were actually using French at the keyboard to discuss possible routes.

This style of CAL was nevertheless unable to present an open-ended context for the material. Much time and energy was spent in the early days on units which did little more than replace flash-cards or overhead projector transparencies. The teacher/developer struggled with the open-ended possibilities in attempting to avoid simple gap-filling exercises. In a discipline that is still so oriented toward accuracy, it was difficult to provide the open-ended environment on the computer that they were beginning to generate in the classroom. In the last year, however, their deliberations have been aided by looking over the shoulders of a different working party developing material for English language teachers.

The English Language Work

This discipline is very different from that of the foreign languages. For the last two decades there has been a well-established shift away from a purely grammatical context, into one of communication and expression [17]. The English teachers were less concerned, therefore, with gap-filling exercises or grammatical tests, but needed to tackle the potential role of the computer to aid free expression and use of

words in combinations of scenarios. This reflected a general interest of English teachers in this style of computer use [18].

For teachers and pupils at home with text and not overly concerned with the use of graphics, an overriding factor was the potential to customize any CAL through using their own words, phrases or sentences. Much interest was expressed in developments such as STORYBOARD [19] and most programs emerged with a basis for exploring words and passages in a variety of combinations. Used as a manager of text, the computer facilitated fast manipulation. It is not the speed of processing that is in itself exciting; it is the discursive use to which such CAL programs are put. Unwieldy "cut and paste" exercises to follow the consequences of word/phrase combinations can be replaced by a fast natural exploration as a stimulant to discussion. Thus the emphasis was moved again to the discussion that takes place among the pupils at the keyboard and the role of CAL in stimulating such discussions.

Branching Story [20], one of the initial programs developed by the CIC English working group, is designed to improve planning and structure in writing a story and also to provide an element of interaction in reading it. After an initial start, the pupils are offered the opportunity to choose a further passage from a binary branching structure. Each branch of the story leads to a different sequence of events, and possibly to a different outcome.

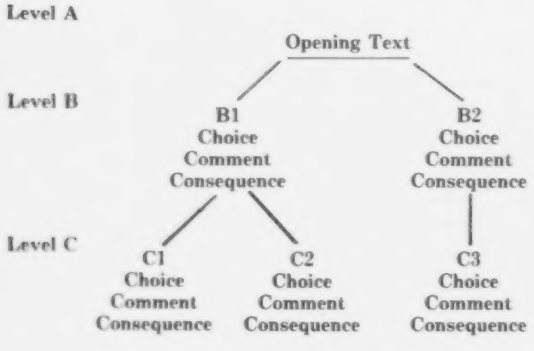

Figure 5.
A possible structure for a branching story

The strength of this unit is that, as the authors, the pupils can write branching stories for their fellow pupils to explore, and each author can comment on the reader's choice of route through the narrative. Thus, throughout both the writing and reading parts of the unit, cooperative work is fostered.

An Adventure Generator

Indubitably the most exciting aspect of the CIC's language feasibility work has been the adventure generator. Just as some classic computer adventure games can teach map-reading and a sense of place, each player of an adventure develops a private mental map of the game's scenario. Such mental maps are highly individual and unique to each player, yet each is produced from the same adventure. An English teacher similarly interested in using adventures, but for teaching English, developed an ambitious scheme in January 1982 to produce an adventure generator for pupils to write their own adventures. Over the last two years this scheme has developed with input from other English teachers and authors so that the prototype is being trailed in schools in Summer/Autumn 1984.

The open-ended nature of the adventure generator demands as limited a number of restraints for entry as possible. It is also necessary to design a user interface whereby the logic of the BASIC code does not intrude upon the way the unit may be used. Thus the Project's programming team, already faced with the relatively limited memory of the main micros available in schools, namely Research Machines 380Z and the BBC Model B, began working within significant constraints.

A fundamental shift took place in 1983 as the framework the English teachers required became less like a traditional adventure generator, and more like a tool for creative writing. Thus carrying objects is less important than the ability to be in a certain frame of mind. The sequences had to cope less with a variety of classic fantasies and became rather a framework in which simple story-telling could emerge.

The whole unit consists of two elements:

sample adventures, which include, for instance, the exploration of a teenager's various emotions and states of mind after a row with his parents; and the generator program to enable groups of pupils themselves to map out and write their own stories to play back. As a reflection of its real nature the title STORYMAKER [21] has replaced Adventure Generator.

One exciting aspect of STORYMAKER is not just the power it can provide for English teachers. Other disciplines have already expressed an interest in using it. Historians are developing an adventure on the exploration of progress in an Elizabethan court in which the power and influence structures rather resembled a minefield. Biologists are interested in producing an Adventure based on the inner workings of the human stomach and intestines. It would seem, therefore, that this program will prove to be a truly interdisciplinary piece of CAL of value to subjects other than the humanities, because of the potential for exploration and discovery it provides in a context-free framework.

Even further possibilities emerge. Planning and writing an adventure-style story is a different occupation from other forms of writing, either through reportage or creativity. To use them effectively, the logic of the adventure story and the frameworks of the program need to be understood. This logic is not structured; it emerges according to the story entered. There are no rigid confines of pyramid or branching structure. The user can think and write in three dimensions, as in the real world, or in circles within circles to reflect the complexity of a nightmare. Once the pupils have mastered the way their own thoughts need to be broken into a sequence for the purposes of entering their story, they are given a free hand in the logic of their own writing. Thus the logic of each story they write is their own. The actual structure of the story is their own. The only constraint is to transfer that structure into the one that is required for entry. Their own story then re-emerges as the program is run.

This seems to be a most powerful pedagogic tool. A teacher working with English pupils on an imaginative story, history pupils on Elizabethan power politics or biology pupils on the workings of our guts can watch the way they develop their own logical paths of thought to reach and move between each scenario. Without the fetters of the classical options, teachers may be able to step back and observe through a window the way pupils develop logical paths of thought. As a tool, therefore, STORYMAKER may provide an avenue for exploration by educationalists as much as by pupils. Out of this feasibility in languages, it is hoped, will emerge a basis for educational research.

Conclusions

The Computers in the Curriculum Project has developed a clear philosophy and model for operation by involving teachers, programmers and curriculum specialists in the investigation and development of CAL materials. It has been a valuable exercise to test and extend this work into a new discipline area. Many related issues, however, need to be addressed:

- how is CAL currently perceived and used in the classroom?
- what sort of classroom organization fosters good CAL?
- what pressures are created by CAL on an already crowded discipline syllabus?
- how successful is CAL at fostering particular styles of learning?

All enquiries must extend beyond evaluating classroom use of materials. The Project also wishes to address itself to the growing relationship between CAL and the moving curriculum. As the potential of CAL and Information Technology is increasingly understood, will the curriculum move in directions not hitherto envisaged or possible? The relationship between education and the new technology it seeks to embrace will be a fruitful area of exploration throughout the 1980s.

REFERENCES

1. R. Fothergill, "The Microelectronics Education Programme—the Strategy." Department of Education & Science, London, 1981.
2. Department of Industry. "Micros for Schools" scheme. Department of Industry Schools Liaison Service. London, 1981.
3. Deryn M. Watson, "Humanities Teachers Write Imaginative CAL." *Proceedings of 6th International Conference on Computers and Humanities*. ed. S.K. Burton, and D.D. Short, Rockville, MD: Computer Science Press, 1983.
4. R. Lewis, & D. Want, "Educational Computing at Chelsea 1969-79" in *Computer Assisted Learning: Scope, Progress and Limits*, ed. R. Lewis and E.D. Tagg, Amsterdam: North Holland, 1969.
5. Deryn M. Watson, "Some Implications of Micros on Curriculum Development," *Involving Micros in Education*, ed. R. Lewis and E.D. Tagg, Amsterdam: North Holland, 1982.
6. Deryn M. Watson, "A Model for the Production of CAL Material," *Computers and Education*, 7:3 (1983), 167-176.
7. Deryn M. Watson, "Enabling School Pupils to Interrogate Census Data," *Historical Social Research*, No. 29 (1984), pp. 66-75.
8. Deryn M. Watson, "The Role of CAL in Decision Making," *Computers and Education*, 8:1 (1984), 31-34.
9. CAMPAIGN—Edward I's Campaign to Crécy (Computers in the Curriculum), Longmans Microsoftware, Harlow, 1983.
10. CHOICE—Disraeli and the Eastern Question (Computers in the Curriculum), Longmans Microsoftware, Harlow, 1983.
11. Dennis Schemilt, The History 13-16 Project (The Director, Trinity & All Saints College, Horseforth, Leeds, U.K.).
12. ARCHEO—Shallow Hill (Computers in the Curriculum Project Unit under development).
13. CALLBOARD, Vols. 1, 2, 3, & 4. Contact Graham Davies, editor, Ealing Technical College, London W5, U.K.
14. CILT Report on autumn 1983 Conference "Assessing Current Programs and Prospects," Contact Eric Brown, CILT, Carlton House Terrace, London SW1, U.K.
15. MILL—Windmill Location Game (Computers in the Curriculum), Longmans Microsoftware, Harlow, 1981.
16. COPROB (Computers in the Curriculum under development).
17. D. Barnes, J. Britton, H. Rosen, and LATE, *Language, the Learner and the School* London: Penguin, 1969.
18. D. Chandler, ed. *Exploring English with Microcomputers*. London: Council for Educational Technology, 1983.
19. STORYBOARD (contact John Higgins, British Council, London).
20. BRANCHING STORY (Computers in the Curriculum under development).
21. STORYMAKER—an adventure generator (Computers in the Curriculum under development).

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ESL Applications of the Computer-Controlled Videodisc Player

David H. Wyatt

The essence of the computer's role in language learning can be described in a single word: *control*. This is not intended to imply control *over* students, but rather a greater degree of control for students, teachers, and course developers over the spoken and written media in which language is expressed. For teachers, this offers an enhanced ability to present language materials and conduct classes in exactly the way they desire. For individuals or groups of students, it means expanded opportunities to work with materials adapted to their interests and abilities, and greater choice in the style and manner in which they use those materials. For both teachers and students, greater control over language media also offers a reduction in the "inauthentic labor" (Kemmis et al. 1977) involved in the learning process.

At our current level of technology, even the most basic computer systems provide much of the necessary control over the written medium. As hardware prices continue to fall, a case can now be made that just one of the functions of this type of equipment—word processing—is sufficient to justify an investment in computer systems for use by both ESL students and their teachers.

As I have argued elsewhere, however, (Wyatt 1982; Wyatt 1984) basic computer systems also have great potential in the reading class. With reading passages presented on their video screens, computers can offer students a choice among a wide range of reading topics, and then deliver different versions adapted to each individual's reading ability. On-line help can be provided with vocabulary, notions, structure, functions, and the like, with information appearing alongside the reading matter on the screen. When necessary, key words for comprehension can be highlighted dynamically to draw attention to them. This brief review of a few possibilities may help to show why computer-assisted ESL reading materials should appeal to those involved in acquisition-oriented and "receptive way" approaches as well as more traditional teaching styles.

Much of this argument applies equally well to the other receptive skill, listening, but unfortunately the basic computer systems are generally inadequate here. Valuable materials can be offered with additional hardware ranging from simple manually controlled cassette recorders to computer-controlled cassettes, rapid-access audio devices, digitizers, and computer-controlled videocassette players; still, to provide the full degree of control over the medium of speech for work with ESL listening skills, the ideal is the computer-controlled videodisc player. For a proper understanding of the pedagogical potential of interactive video, it is necessary to have a general grasp of the hardware. We will briefly review videodisc players and their control by computers.

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Videodisc Hardware

There are a number of competing formats of videodisc, but the North American standard for education and training purposes is the optical reflective videodisc, or laser disc. Several

models of the laser disc players are sold by companies such as Pioneer, Magnavox, and Sony. Since, in general, these are completely compatible, the same laser disc will be playable on any of the models.

In content, a laser disc is very similar to a video cassette. Both were designed originally as television or motion picture media. Thus, they generally carry both moving pictures and an accompanying soundtrack, although they can just as well hold only audio material or video material.

Standard laser videodiscs are permanently recorded. They may be considered the audiovisual equivalent of phonograph records (video cassettes being analogous to audio tapes or cassettes). Producing a new videodisc requires a mastering process (performed by specialized factories) based on videotape, equivalent to the production of phonograph record masters from high-quality audio tape masters. (It should be noted that videodisc players with recording capabilities are now becoming available. They use blank videodiscs that cannot be erased once a recording has been made. Unfortunately, videodisc systems with recording capabilities are likely to be prohibitively expensive for most educational purposes for several years to come.)

Laser discs are currently recorded in two main formats. The first type is known as standard play and is recorded at constant angular velocity (CAV). This is the format that lends itself to educational purposes. It provides up to 30 minutes of continuous motion picture play per side. The second recording method is termed extended play because it offers twice the playing time—one hour of continuous motion picture play on each side of the disc. This format, recorded at constant linear velocity (CLV), is unsuitable for most educational purposes.

On a videodisc, the basic recording unit may be thought of as the *frame*, which may comprise a complete video picture with its momentary accompanying soundtrack. Such a frame could form part of a motion picture sequence. When these frames are shown at the standard rate of 30 per second, the result is a continuous motion picture and soundtrack. Videodisc pictures are of the highest quality, and the audio is high fidelity with individually controllable stereo tracks. Of course, there is no requirement that a frame be fully utilized. It might contain audio information only (blank picture), video only (no soundtrack), or no audiovisual information at all.

On a standard play (CAV) videodisc, there is an exact correspondence between a single frame and one circular track on the disc. Thus, track one (close to the center of the disc) contains the information for frame one; track 54,000 (near the outer edge of the disc) holds the information for frame 54,000. Instead of starting a film sequence from the beginning, then, we can specify the exact frame at which to begin play. Moreover, play need no longer be standard speed or continuous. If the videodisc player is instructed to play each frame several times before moving to the next in the numerical order, flicker-free slow-motion is produced. Any frame can be used as a still frame ("freeze-frame") by playing it repeatedly. Other special effects, such as fast forward motion and slow or fast backward motion, can be produced. (With current standard laser discs, however, the audio track would be distracting and is simply turned off except during continuous play.)

The ability of CAV videodiscs to display single frames opens up another possibility: the recording of individual pictures from any source—slides, transparencies, and the like—as part of the disc material. If only stills are recorded, up to 54,000 pictures can be accommodated on each side of the disc. Thus, depending on their purpose, CAV videodiscs may contain individual pictures, motion pictures with audio, motion pictures without audio, and audio without pictures in any combination.

Any CAV videodisc can be played under manual control on a videodisc player. A commercial movie recorded in this way will simply play the tracks from start to finish on the current side of the disc if nothing else is specified. However, using the manual controls on the player (which include a numeric keypad on which frame numbers can be specified), the user can at any time go directly from one frame to any other frame on this side of the disc, start play, display an individual frame, or employ any

of the other special effects.

Even under manual control, then, a commercial movie or television film can be radically "adapted" for new purposes. Selected movie sequences with audio, or still frames, can be shown in any order. In this *repurposing*, one set of selections might be integrated with a particular lesson. Later, different scene and dialog selections from the *same* disc could be used in a new lesson.

The value of *controllable* audio materials accompanied by a full vido context, even with a manually operated, stand-alone videodisc player, should not be underestimated. In practice, however, manual control limits students to very simple operations. Even the replaying of the last few seconds of a scene soon becomes tedious when frame numbers and commands must be repeatedly specified on the player.

Computer-Controlled Videodisc Players

To take full advantage of the educational potential of CAV videodiscs, a powerful, programmable controller is required. Some videodisc players come with a built-in microprocessor that can exploit part of this potential. These "intelligent" videodisc players are known as Level Two systems as compared with simple stand-alone players (Level One systems). The possibilities are greatly expanded, however, when a computer is used both to control the videodisc player and to allow the full range of other computer-assisted learning techniques to be implemented. Microcomputers, in particular, fill this need admirably (DeBloois 1982). These computer-controlled videodisc systems are known as Level Three systems, and the activities that they make possible will be designated computer-interactive video, or CIV.

Almost all laser disc players are designed for remote control, which in its simplest form is provided by a small hand-held unit that duplicates all the usual manual controls, including a numeric keypad for frame specification. Some hand-held units communicate with the player via infra-red waves, but even on these systems a controller can generally be directly wired in to the player.

In principle, the task of a computer program in controlling a videodisc player is thus very simple: to duplicate the electronic signals sent to the player when the buttons on the player itself (or on the remote controller) are pressed. Theoretically, this requires that an output channel from the computer be wired into the remote control socket on the player. For example, to display under manual control a still picture stored as frame 25,000, we press the SEARCH button, then the numbers 2-5-0-0-0, then SEARCH again. Each of these buttons generates an electronic code recognized by the player. To produce the same effect, all a computer has to do is to transmit the same electronic pulses to the player.

In practice, the simplest way to achieve this is to provide a special-purpose interface between computer and videodisc player. The player will be connected to a color monitor or TV and, when instructed by the computer program, will display the appropriate audiovisual sequence, still frame, or the like. The computer has its own monitor or TV which displays computer-generated text and graphics as usual.

With this type of system, movie videodiscs and other discs designed for continuous stand-alone play can be repurposed for language learning in the flexible manner outlined above. However, new types of videodisc material can also be produced specifically for this type of system. In a "conversational simulator" disc, for instance, the first scene may be followed by a choice between four conversational responses. Depending on the learner's choice, the system can jump (under computer control) to one of four different continuations of the conversation. These might be recorded sequentially on the disc. Under computer program control, only one of the continuations would be seen by the learner. (Such videodiscs would seem baffling if played continuously on a stand-alone player. After the initial scene, each of the four continuations would be played in sequence.)

ESL Applications of Computer/Videodisc Systems

Computer-controlled videodisc systems have

significantly different implications depending on whether they are used with individual students (and small groups) or with the class as a whole. These two situations will now be addressed in turn.

Individual and small-group situations

In discussing CIV materials for language learning, there is a fundamental question to be answered: should they be aimed primarily at listening skills, speaking skills, or both? With individuals or small groups, the answer seems overwhelmingly clear. CIV techniques appear to have considerable potential for listening but relatively few valid applications for speaking skills.

There is a compelling parallel here with audio tape programs and the language laboratory. Insofar as audio tapes (inside or outside a language lab) can provide students with extended, controlled opportunities to listen to the target language, it is difficult to deny their potential value to learners. When used predominantly to provide models for oral repetition and response, however, audio tapes and the lab have been unconvincing vehicles for language learning.

I have argued elsewhere (Wyatt 1984) that computer roles in language learning can be clarified by making a broad division into three main types: *instructional, collaborative,* and *facilitative* applications. This classification will be used in the following discussion of CIV materials.

Within the *instructional* paradigm, we will examine two main kinds of CIV application: those based on custom-produced ESL videodiscs, and those which exploit commercial movie videodiscs, documentary discs, and the like.

If the funds are available to develop custom-designed ESL videodiscs, CIV systems offer a real "first": the opportunity to fully implement a listening skills curriculum in a systematic, individualized, self-paced manner. When working with listening materials in a general class context, teachers are all too aware of the divergent range of student abilities facing them. Some students need frequent repetition, or a slower pace of speaking, or more visual clues to meaning; others need none of these and could profit from more challenging materials if the teaching situation permitted this. A worthwhile degree of individualization is obtained by providing students with self-study materials based on audio tapes, whether inside or outside a language lab. However, audio materials without a visual context should be the end of a listening skills sequence, not its main component. Further, these traditional self-study materials lack the important range of assets, outlined below, that computers can provide.

In a hypothetical computer-interactive video course in ESL listening skills, one unit might be concerned with the functions of expressing ability or inability to do something, and the exponents covered in this part of the lesson might be *can* and *can't*. Part of this side of the laser disc is occupied with a number of brief dialogues in which ability/inability is being expressed: "I can ride a bike, but I can't drive a car." The dialogues are recorded along with a natural, helpful visual context. The student is using a system with a videodisc player under the control of a computer. The computer screen is offering a "menu" of choices; we select the first, "Begin the lesson," by typing *1* on the computer keyboard.

The computer screen now tells us to "watch the other screen," and after a brief pause the first video sequence and dialogue is shown on the color monitor attached to the videodisc player. As the color monitor "freezes" on the last frame of the dialogue, we shift our attention back to the computer screen, which is now displaying the first listening comprehension question based on the dialogue plus options to repeat the dialogue, skip this question, etc. Deciding to repeat, we press *R,* and almost instantly the videodisc player starts up and begins showing the dialogue again.

This time we believe we know the answer to the first (multiple-choice) comprehension question. Selecting an answer, we discover that we were wrong. The computer displays the message "Watch and listen again," and the videodisc begins to operate. This time, however, it shows just the part of the dialogue that includes the answer and then returns to the multiple-choice question display (we notice that the

choices are now in a different order). We again make a selection, and now we have the right answer. The computer screen begins to display the second question, and we move on similarly through the lesson.

Later in the course—perhaps in the next lesson, or possibly several lessons from now—the same dialogues on the videodisc may be used again, but with the video turned off and in a different order. In this way, students can return to work with the more difficult task of listening without visual clues. With a suitable CIV system, the use and re-use of any portion of the videodisc, with or without the video, left audio track, or right audio track, is entirely under computer program control. Since the audio tracks are independent, versions of the dialogues could be recorded at two different levels of difficulty, or in the native and target language.

Many of the advantages of CIV systems for ESL listening comprehension courses may be inferred from the above description. Individualization and self-pacing are two major benefits for students. A third is that CIV permits working from speech combined with visual context to speech alone, the natural progression which has unfortunately not been possible with the traditional listening comprehension self-study courses. The computer's ability to evaluate answers without revealing the correct ones permits students to try again and work toward the right answer, rather than simply being "wrong"—a far more effective approach to learning in individual-study situations.

Very similar advantages are found in the other main possibility for instructional CIV courses, the exploitation of existing commercial movie or other videodiscs. Under computer program control, brief dialogues could be selected from anywhere in the 30 minutes of material on a videodisc side. For example, dialogue excerpts could be chosen to illustrate past tense expressions, with questions and lessons built around them in very much the same way as with custom-filmed materials. With existing videodiscs not designed for ESL purposes, it would generally not be feasible to achieve as precise an instructional focus as with customized discs. The more holistic type of material that would result might be more appropriate for intermediate and advanced learners rather than beginners.

The above descriptions, intended to provide some concrete examples of the *instructional* type of CIV material for listening skills, illustrate only a fraction of the possibilities. In general, computer-interactive video systems will permit most of the familiar instructional activity types—tutorial, drill-and-practice, and holistic practice—to be implemented for listening skill development. Proponents and opponents of instructional approaches should find the same general benefits and disadvantages in CIV materials of this type.

Now let us examine the potential for *collaborative* CIV programs—activities in which the CIV hardware will function more as a linguistic environment for students to explore, an environment in which they will initiate much of the action and take more responsibility for their learning. A distinction will again be made between courses with custom-designed ESL discs and those built around existing commercial videodiscs.

One attractive format for custom-designed ESL materials is the conversational simulator. In many ways, this format resembles a linguistically-oriented adventure, as the materials are designed as a set of short scenes filmed from the student's point of view with the student playing the role of protagonist.

One such program might begin by setting the scene. The student is in an unfamiliar part of town, and must get to the main post office before it closes in order to send an urgent letter by express mail. The videodisc now starts up, and the first scene presents a ragged-looking "street person." After a few words from him, the scene "freezes" and the computer screen offers a choice of responses. We choose one of them and, based on our selection, the videodisc now displays one of several possible "next scenes." Unfortunately, in our case the street denizen begins to pester us. We are wasting time and getting nowhere! We try a different response at the next opportunity.

This type of CIV material can provide an

extremely attractive language environment in which students can experiment in a self-directed fashion. Such courseware develops more than just listening skills, particularly if used by small groups of students, when it tends to generate animated discussion about what options should be selected and the results of those choices. An excellent example of a conversational simulator videodisc for Spanish has already been developed (Schneider and Bennion 1983).

Among the existing commercial videodiscs, at least two murder adventures designed for native speakers offer scope for repurposing: *Many Roads to Murder* and *Murder, Anyone?* (1). These CAV format discs were originally designed to operate in stand-alone fashion. Under computer program control, they can easily be adapted for ESL purposes.

The linguistic difficulty of these commercial videodiscs might make them appear suitable only for the most advanced students. The evidence from CIV research so far, however, indicates that students are willing to work with, and can profit from, materials that would normally be well beyond their level (Bush et al. 1983). They appear to respond to the high degree of self-pacing, repeatability, and other types of control that they gain through CIV systems, as well as the sheer attractiveness of well-produced video programs.

Again, this is a very small sample of the possibilities for collaborative approaches with computer-interactive video systems. Other collaborative CALL formats, notably simulations, could fruitfully be transferred to CIV.

VALT materials could serve a very wide variety of purposes in teacher/whole class situations. Film sequences could "set the scene" for the lesson theme. Still frames could be used as drill stimuli or discussion starters. Short dialogues could be used as realistic speech models or to lead into role-playing activities. Sound could be turned off during some dialogues to encourage student creativity as in recent videotape materials such as *Speak Easy* (2).

It should be noted that these VALT applications do not require computer control and are thus quite distinct from CIV. Video-assisted language teaching can be based on videotape rather than videodisc players. Recently, courses with an increasing degree of dependence on videotape have been appearing (3). A brief comparison of the merits of tape versus disc is given below.

Disc or Tape As the Basis for CIV?

The choice between videodisc and videotape is not a clear-cut one, depending partly on the CIV application, although for most workers videodisc is the ultimate medium of choice (Stevens 1983). Matters are further complicated by periodic changes in the technical capabilities and commercial formats of both videodisc and videotape players.

The videodisc is clearly superior for applications in which existing material is to be used. Videodiscs offer direct access to any frame on the current side of the disc within a few seconds (or less than a second, with more expensive players). Videotape access times may be unacceptably long, since fast forward and fast rewind must be used to move sequentially through the tape. Videodiscs are far more durable; they do not deteriorate like tapes in normal use, even when used in freeze-frame mode, and are much harder to damage accidentally. Videotape access was formerly far less exact than with videodiscs, but frame-accurate access is now possible with controllers such as the BCD interface board (4).

For application in which new material is being developed, however, videotape is the only economical option that is recordable and modifiable. New recordable videodisc formats are now becoming available, but currently there is no affordable option for standard laser videodiscs. Nevertheless, once the tape programs have been finalized, it may be desirable to convert them to videodisc. Disc mastering and pressing of a small number of copies is now possible in just three days at a cost of $3,000 through the 3M Company or similar videodisc plants (5).

Types of CIV System

Mentioned earlier in this article, the simplest type of CIV system employs a one-way channel of communication from the computer to the

videodisc player, each of which has its own video display. In essence, the computer just "presses the buttons" of the player by means of a special interface. A typical interface is the Discmaster 1000 (6), designed to enable an Apple II computer to control a number of videodisc player models.

These simple systems suffer from a number of drawbacks. Because the videodisc player cannot tell the computer when it has finished playing a sequence or located a frame, the programmer may need to build in complicated "wait" loops and hope that they give the player sufficient time to complete an operation. Also, since they use two different screens, there is no possibility for educationally useful "overlaying" of computer labels or graphics on top of videodisc pictures.

More powerful interfaces are now becoming available to overcome these problems. While controlling a variety of videodisc players from the IBM Personal Computer, for example, the V:Link 1000 (7) permits the display of computer text, computer graphics, videodisc pictures, or any combination of these on the IBM's own color monitor. This interface also permits the computer to monitor the status and current frame position of the videodisc player, eliminating the need for "wait loops."

Past, Present, and Future: Some Considerations

Remarkably little work has been done in computer-interactive video for any language. Two meritorious projects in Spanish are *Macario* (Melendez 1980) and *Montevidisco* (Schneider and Bennion 1983), while the interesting German disc *Klavier im Haus* has been repurposed in a variety of ways (Luckau 1982; Bush et al. 1983). Further German and ESL projects based on custom-filmed video are in production.

The most immediate, practical approach for any language would be to build course materials around existing discs. For ESL purposes, there are at first sight approximately 1,000 commercial laser videodiscs in English, predominantly movies, from which to select. Unfortunately almost all are recorded in the extended play (CLV) format, unusable for educational purposes.

In CAV format, however, enough discs have been recorded to form a reasonable starting point for ESL experimentation. Equipment costs are already within the reach of many educational institutions. Computer-interactive video in ESL appears to be an area whose potential will surely be tapped in the near future.

NOTES

1. These laser videodisc-based adventures were produced by Vidmax. They are available from Starship Audio, 605 Utterback Store Road, Great Falls, VA 22066; (703) 430-8692.
2. *Speak Easy* is based on mime sketches recorded on videotape. From BBC English by Television, Bush House, London WC2 England; 257-2765.
3. A new course that is highly integrated with videotape is *Your Life in Your Hands* by Joseph Deliso. Available from Longman Publishers.
4. BCD Associates manufactures an interface board for the Apple II which will control a number of videocassette recorders. BCD Associates, 5806 Southwest Fifth St., Suite 101, Oklahoma City, OK 73128; (405) 908-1293.
5. The 3M Company offers rapid production of videodiscs: Optical Recording Project, Dept. S, 223-5S, 3M Center, St. Paul, MN 55144; (612) 733-1110.
6. The Discmaster 1000 interface board enables the Apple II to control a number of videodisc player models. From New Media Graphics Corp., 279 Cambridge St., Burlington, MA 01803; (617) 272-8844.
7. The V:Link 1000 interface board enables the IBM PC to control videodisc players. From Visage, Inc., 12 Michigan Dr., Natick, MA 01760; (617) 655-1503.

REFERENCES

DeBloois, Michael L., ed. 1982. *Videodisc/Microcomputer courseware design*. Englewood Cliffs, NJ: Educational Technology Publications.

Bush, M.D., G.A. Mueller and D.M. Schrupp. 1983. Klavier im Haus—An interactive video experiment in foreign language instruction. *CALICO Journal* 1:2, 17-22.

Kemmis, Stephen, Roderick Atkin and Eleanor Wright. 1977. *How do students learn? Working papers on computer-assisted learning: UNCAL evaluation studies*. Norwich, England: Centre for Applied Research in Education.

Luckau, Paul. 1982. Klavier im Haus—an annotated version. In *Proceedings of the FLINT Conference*. 127-37. Monterey, CA: Defense Language Institute.

Melendez, Gloria S. 1980. Interactive instruction in Spanish interfacing the microcomputer and the videodisc. *MICRO* 1:1, 11-12.

Schneider, Edward and Junius Bennion. 1983. Veni vidi vici via videodisc: a simulator for instructional conversations. *System*, 11:1, 41-6.

Stevens, Vance. 1983. A report of a project illustrating the feasibility of video/computer interface for use in ESL. *CALICO Journal* 1:1, 27-30; 50.

Wyatt, David H. 1982. Teaching the receptive skills. In *Proceedings of the FLINT Conference*. 45-50. Monterey, CA: Defense Language Institute.

———. 1984. *Computers and ESL*. Washington, DC: Center for Applied Linguistics, and New York, NY: Harcourt, Brace.

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Book Reviews

***Computers and Composing: How the New Technologies Are Changing Writing*, Jeanne W. Halpern and Sarah Liggett. Conference for College Composition and Communication, Southern Illinois University Press, Carbondale & Edwardsville IL: 1984; 144 pp., paperback. ($8.50)**

by Marion Larson

This work is the first in a series of Studies in Writing and Rhetoric, published for the Conference on College Composition and Communication. Clearly oriented toward teachers of college-level writing, *Computers and Composing* is a very forward-looking book. As Edward Corbett puts it in his prefatory comments, Halpern and Liggett's goal is "to acquaint us with the potentialities of the electronic hardware, to show us what changes writers may have to make in their composing habits, and to inform us of the changes we may have to make in our syllabi in order to prepare our students for the demands of the electronic world" (xi).

In discussing such ever-changing technologies and their effects on writing, one might expect computers to be the center of examination. And, indeed, Halpern and Liggett's title claims such a focus. Computers, however, receive virtually no mention. Instead, the authors center their discussion on research they have done with the rise in spoken and dictated texts, a trend made necessary with electronic mail, dictation machines, and other new business communication media. They survey writers on the job who currently must adapt to these new media. Their observations of such professionals suggest possible new directions in the classroom and in research, both areas this book touches upon.

Such contact with "real world" writers leads the authors to conclude that students must be impressed with the need for flexibility and for strategies that help them adapt to each new writing situation. This thesis is not new, but the authors' applications are: they point out that the new media force writers to adapt their planning, drafting, and revising strategies to each medium, focusing especially on effective ways to convert speech into writing. Included are some innovative and specific classroom exercises to help teacher-readers see possible ways of putting these principles into practice. For example, using dictation in a business writing exercise helps students see new problems that arise while working to turn dictated speech into writing: in planning, in communicating with their immediate and future audiences—the transcriber and then the reader—and in drafting.

In keeping with their practical emphasis, Halpern and Liggett suggest a general writing course objective: "to introduce students to the new communication systems and help them adapt the process of pen-in-hand composing to the challenges of the new systems." And research such as theirs helps us to do just that, especially in business and technical writing classes. One only wishes, given the title, that the research had tried to describe the role of the computer itself, rather than its anonymous operator in the corporation's word-processing pool.

***Exploring English with Microcomputers*, ed. Daniel Chandler. Council for Educational Technology, London: 1983; 123 pp., paperback (£4).**
***Computers in the English Classroom*, Sally N. Standiford, Kathleen Jaycox, and Anne ..uten. ERIC and NCTE: 1983; 55 pp., paperback, ($8.50).**

by Laura Brady and Marion Larson

Aptly titled, the first book, *Exploring English with Microcomputers*, provides miscellaneous essays which look at the uses of and possibilities for computers in the teaching of English. Each chapter (or essay), while quite short, is filled with concrete examples to orient teachers unfamiliar with computers in instruction. Although one might wish for a more coherent pattern to this book's essays, still on the whole, this eclectic approach seems suited to editor Daniel Chandler's intended audience: "English teachers who are intrigued, amused, or even shocked by the idea that computers can have anything to do with a subject in which imagination and sensitivity play so great a part."

Perhaps the strongest essays in this brief collection are Chandler's introduction, which gives a good opening discussion of the theory and pedagogy which supports computer use in English instruction; and the final chapter by Jan Bright, "The English Teacher and the Programmer: How Can They Talk Together?," which discusses the types of features to be considered or desired in computer programs for English. This last chapter also suggests specific ways in which an English instructor can work with a programmer to design programs that are both tailored to student and teacher needs, and feasible for computer hardware and software limits.

Although the other chapters in the book are somewhat anecdotal reports on projects and experiments conducted in the United Kingdom, they share some virtues: they give concrete applications for secondary-education English instruction; they focus on writing and problem-solving as the best uses for computer-assisted learning; and they carefully avoid behavioristic, programmed computer-learning. The entire book emphasizes the use of computers as a creative language tool and learning aid, not a system for imposing and monitoring programmed learning.

Exploring English with Microcomputers may not develop either a coherent program for using computers in classrooms or a strong application and defense of the theory and pedagogy of computer-assisted learning, but it does, with practical examples, explore the broad possibilities and potentials for developing uses of computers in building skills such as creative writing, revising, language development, and group interactions and responses to writing.

Fantasy treasure hunt games, like Derrick Daines' version of the ever-popular "Dungeons and Dragons," for example, allow students to work together to discover question-asking strategies as they try to find their way through a computer-simulated maze. Such collaboration aids in language development, contends contributor Jan Stewart, because it promotes *purposeful* (i.e., goal-directed) group discussion.

Whether in group work or exercises structured for individuals, microcomputer programs encourage student investigation (the "exploring" promised in the book's title). Good software should do just that, urges Jan Bright: "it should encourage students to ask [and then find out] 'What would happen if . . .'," creating an atmosphere where they are free to try options of their own creation.

By giving such specific examples, the book is a helpful introduction to computer-assisted learning—more helpful than a primer of terms, hardware, and software for one who really needs some educational issues raised and some

Laura Brady and Marion Larson, doctoral candidates in English at the University of Minnesota, are developing computer-based curriculum materials for the project on computers and writing funded by FIPSE (Fund for the Improvement of Post-Secondary Education) and directed by Donald Ross and Lillian Bridwell.

questions answered before jumping into the technical aspects of computers in the English classroom.

Less satisfactory is the book from the National Council for Teachers of English (NCTE), but not because of its failure to address technical and computer issues. Standiford, Jaycox, and Auten start with a sound and valuable aim: to explore the capabilities of the computer as a new teaching tool in the English classroom. Unfortunately, because of their heavy emphasis on structured, mode-driven learning, what they present is a picture of computer limitations. From this perspective, the computer becomes a tool for behavioristic programming of students rather than an aid to creative learning and the development of cognitive skills.

This linear and thus limiting presentation of computer use in the classroom keeps the focus of this book on drill instruction. English instruction, as a result, seems to be equated more with delivering facts than with generating and exploring ideas and questions. Chapter two accurately states that "the vast majority of English lessons currently in use implement a drill or practice strategy." This statement, however, overlooks the new emphases of process approaches, while implicitly endorsing modes of discourse (the authors still refer to the "standard five paragraph theme"), and the behavioral psychology of "positive reinforcements." When the authors do mention problem solving strategies in connection with computers, they refer to the complexity of designing such open-ended programs and state that the computer's function is to "prod" the student on to the next step in the composing process; a linear, task-oriented perspective.

Chapter three presents two diagrams of computer-based instructional materials: a simple (linear) decision tree, and a complex tree with multiple end-points. The possibilities of the second tree look provocative, but receive little discussion, perhaps because sophisticated, interactive programs are not currently available. But a primer should introduce the potential uses as well as the current state of the art, especially if its intent is (as the authors state in their introduction) to allow teachers to make intelligent, informed decisions about computers in their classrooms.

As a first guide to the use of computers in teaching writing at a secondary level, this book never achieves its intended purpose. There are no concrete examples to illustrate the guidelines for an "intelligent, informed decision." The last chapter gives minimal cross-references for the evaluation of computer courseware, but these are references drawn largely from ERIC sources and therefore are less representative than they might be of what is available.

Overall, the first chapter remains a solid, helpful introduction to hardware, software, and terms. Such technical points, however, seem less crucial to a first guide than an exploration of the computer as a new creative tool. This book is, finally, an over-simplified, over-generalized primer which looks more closely at computer limitations than at computer potential within the English classroom.

Errata for "The Authorship of a Lover's Complaint" by M.W.A. Smith, in 18:1 (Jan.-Mar. 1984).

p 24, right hand column, 15 lines from bottom: delete the sentence "Mention should be made .... contributions are known."

p 25, right hand column, first line should read "The frequency of usage tests are based on the ...."

p 29, right hand column, last line of the first paragraph, delete "in parenthesis." The line should read "value of chi-square is also shown."

p 32, left hand column, fifth line from bottom, should read "demonstrated by both the collocation and the proportional ...."

p 32, right hand column, second paragraph, line 10, should read "Since the texts of *Venus and Adonis* ...."

p 33, Table 8. Word IT for *Venus and Adonis:* replace the dash by 5 under "lws."

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